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Australia's Top Selling Electronics Magazine

Electronics Australia

MAY 1987
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Hermes: The French space shuttle

AUSSAT
The best is yet to come

REVIEW: New NAD amplifier

Battery monitor for your car

Simple mixer for your hifi

Op amp tester to build

BONUS! 148-PAGE DICK SMITH CATALOG

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Volume 49, No.5

Electronics Australia

May 1987

THIS MONTH'S COVER

Essentially a scaled-down version of the US space shuttle, France's Hermes space plane will be blasted into space atop an Ariane 5 rocket (see also page 42).

Features

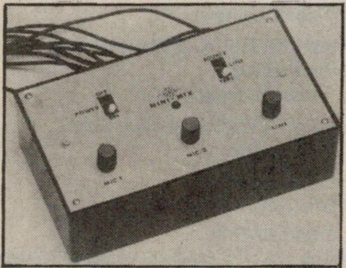
Entertainment Electronics

Projects and Technical

News and Comment

Departments

Low cost stereo mini mixer

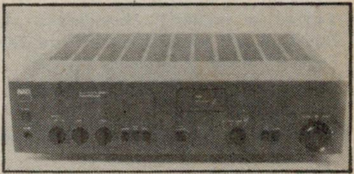


This Mini Mixer plugs into your hifi amplifier and lets you mix two microphone inputs with line level signals. It's just the shot for small public address applications. Details page 28.

What's coming

Next month, we intend to describe a multi-function infrared remote control. We'll also be taking a look at the basics of satellite TV reception. See page 130 for further details.

NAD 3240PE stereo amplifier



NAD's new 3240PE stereo amplifier is an impressive performer. Don't miss our review starting on page 20.

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Letters to the editor

AM stereo and CD sound

I read your March article on AM stereo with considerable interest. I recently hunted around for a good quality sound source for our caravan. I had a choice of mains operation (via the 300W inverter from batteries which are solar charged) or a car unit.

The ignorance of the salesmen was depressing. One argued with me that AM stereo was no good and that all stations were switching to FM. He tried to convince me that I didn't want an AM stereo tuner even though that is what I asked for!

I have experienced broadband AM for years and have Quad AM3 and an AWA AM3 broadband tuners in our house, so I know what I am talking about. The muffled quality of the standard AM tuner leaves me frustrated as speech is considerably harder to decipher and the music much less enjoyable.

Even in the car I can appreciate the broadband clarity of speech and music from my Eurovox MCC-2360. In my opinion, there has been too much discussion about the stereo aspect of AM tuners and not enough about the broadband aspects. Most commercial AM tuner equipment is dreadful in this area.

My search for a good sounding unit with a broadband AM stereo tuner revealed nothing suitable in the 240V line, and little in the car radio-cassette market. The only equipment which measured up was the Eurovox so I purchased another (now superceded) 2360.

I agree with I. Stephenson that I have yet to hear a CD sound source equal to top vinyl playing gear. I sometimes wonder if Neville Williams has heard a really good vinyl playing set up because of the way he heaps sarcasm on those of us who remain unconvinced of the miracle of CD.

In fairness, the CD is a much more economical way (ignoring the price of records) for most people to hear high quality sound. Most low and mid-priced record players are pretty dreadful and what you haven't ever heard you won't miss. However, once one has been exposed to a high quality vinyl setup where the music (not the hifi) is listened to for hours on end, then the illusion of music is far more satisfying than on any CD player I have fed through my system.

The disappearance of vinyl records from the stores is happening rapidly. I only hope that by the time they disappear altogether, and this seems inevitable, CD players will have improved so that violin strings etc really do sound harmonic and not relatively harsh as at present.

What one is prepared to accept in the area of sound quality depends on circumstances. I can enjoy music on a low quality portable radio or cassette unit. I can enjoy the reproduction in our car or caravan. However, when I sit in our lounge room to listen to the illusion that recordings can provide, I find I get the most enjoyment from vinyl.

John Coulson,
Dilston, Tasmania.

Fault report from the Serviceman

I would like to suggest that *Electronics Australia* prepare a list of faults that the Serviceman has written about, giving manufacturers' names, set model numbers, and the year and month in which each was described. Has this ever been done?

This information could be used to supplement information in service manuals and make repair work easier. It could also increase the profit in your back issues department.

Greg Love,
Georgetown, NSW.

CDs offer repeatable sound quality

After reading your February issue of *EA*, I found Mr Graf over the top in regards to the article you wrote about CD players. While what he says may be true, I find it very hard to swallow.

I've longed for the day that I could listen to my records over and over. The truth of the matter is that a small majority of die hards are supporting an old

technology. These people probably have stacks of money to lash out on a high quality turntable and new records every time the old one gets dust on the tracks or the stylus accidentally slides across the record. I don't suppose Mr Graf could be biased towards vinyl just because he is in that field?

I've spent hours listening to records which had sounded great only to find that they lose their quality after a couple of plays. In my case, I listen to the record until I can't stand the deteriorating sound anymore. After that, the record will only be used on desperate occasions. It is almost an idealistic attitude to think that the majority of hifi fans would prefer vinyl to CDs.

Just for the record, I don't own a $1000 rack system. The speakers alone cost more than that and my turntable does have belt drive, etc.

To conclude, I personally am of the opinion that for the money I have to pay out for music, I want quality and value. Even though CDs are not the best in the price war they do provide repeatedly good quality musical reproduction. And in my case that is what I feel has been lacking — repeated high-quality playback.

D. Wilson,
Chelsea, Vic.

The dangers of beryllium oxide

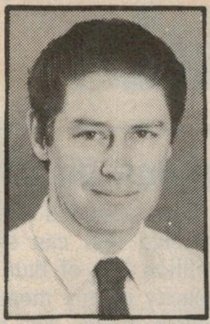
I would like to add to the comments made in your February issue by Norman Marks. Having recently spent five years working with organo-beryllium compounds, I feel that I should point out that beryllium oxide is most definitely regarded as toxic, particularly when it is finely divided. Although beryllium and its compounds are known to cause "non-healing wounds" when cuts or abrasions are directly contaminated, the insidious nature of these substances results from their effects on the lungs.

Inhalation of even minute amounts of beryllium or its compounds can cause fatal lung disease, sometimes as long as ten or fifteen years, after exposure.

Presumably though, the use of heatsink grease containing beryllium oxide would be unlikely to result in the inhalation of the oxide.

For those readers interested in further reading, "Patty's Industrial Hygiene and Toxicology" 3rd Ed., Vol 2A, G.D and F.E. Clayton, Eds., John Wiley and Sons, 1981 contains a review of beryllium toxicology.

Dr S.J. Pratton,
Dudley, NSW.



Editorial Viewpoint

VCRs and audio gear must be approval tested

The editorial in the March 1987 issue on electrical safety produced a lot of positive feedback which has been quite gratifying. It also pointed up a related topic which should be aired.

This concerns the lack of approval testing for audio and video equipment. While most domestic electrical appliances are subject to rigorous approval testing by state government energy authorities before they can be sold, this is not the case for domestic audio and video equipment. This situation should not have been allowed to go on for as long as it has, for a number of reasons.

Prime among these is the fact that most audio and video equipment being imported these days is branded as being double insulated. This is indicated by a "square within a square" symbol on the back of the appliance. Now as far as we are concerned, some if not most of this so-called "double-insulated" equipment would not pass muster if it was subjected to approval testing, to the relevant Australian Standards.

For example, one of the requirements for double insulation is that mains wiring inside the appliance should be sheathed to prevent it from touching the chassis. We also look askance at the type and quality of some mains switches and the lack of effective anchoring of mains wiring, to prevent the possibility of broken wiring touching the chassis. Then there is the question of the insulation standard of the transformer.

Now the fact that double-insulated equipment might not pass muster is one concern but it is our belief that most video recorders and at least some audio equipment should not be double-insulated at all but should be earthed, via a three-pin plug and three-core flex. The main reason for this belief is that most VCRs have a lot of ventilation slots at the top and these can allow ingress of water, if for example, a drink is spilt over the machine. Once that happens, the chances are that the supposedly double-insulated chassis will now be live and very dangerous. It's another case of water and electricity being a dangerous combination.

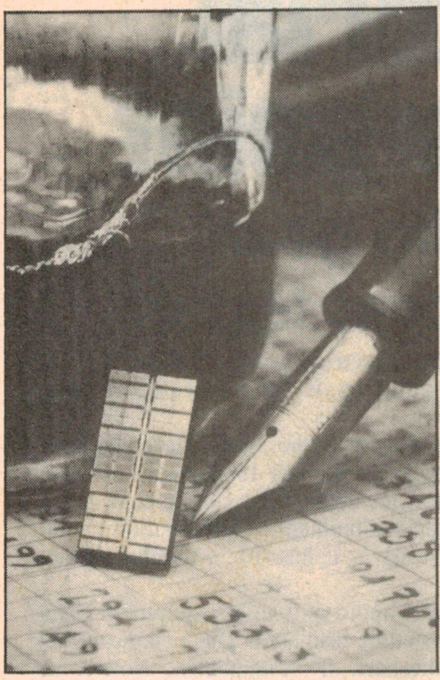
We believe that all hifi amplifiers should also be earthed. The reason for this is that in a typical hifi installation there may be four or more mains-powered "double-insulated" program sources (eg, turntable, tuner, cassette deck and CD player) connected to the amplifier. All of this gear multiplies the chance of an insulation failure.

If the amplifier is earthed, it would automatically prevent such an insulation failure from becoming a dangerous situation. Sure, by having all the equipment double-insulated, there is no possibility of annoying hum loops, but safety must come first.

It is our belief that all domestic appliances should be subjected to the same rigorous approval testing. The importers will rightly point out that this is an expensive and time-consuming procedure. However, approval testing can be done in Australia or overseas by approved organisations, so that is not an argument. Safety should be paramount, so all domestic electronic gear should be tested.

Leo Simpson

News Highlights



The four-million bit chip!

IBM engineers have designed a new computer memory chip that can store more than four million bits of data — four times the capacity of any memory chip used in computers today. The new chip has been fabricated on the same manufacturing line used for volume production of 1Mb chips at IBM's semiconductor facility in Essex Junction, Vermont.

According to IBM, the new 4MB chip can store the equivalent of about 400 pages of double-spaced typewritten text. It also operates at very high speed speed and can access a single bit of data in just 65 nanoseconds compared with 80 nanoseconds for IBM's most advanced one megabyte chip. At this speed, all of the chip's 4,194,304 memory cells could be read in less than one quarter of a second.

As with previous RAM chips, each memory cell in the new chip is composed of one transistor and one capacitor, with information represented by the presence or absence of charge on the surface of the capacitor. In the 4Mb chip, however, IBM is using a new method for constructing the individual storage cells. A hole is etched deep into the silicon at each storage location on the chip, the sidewalls covered with insulating material, and the hole then filled with a conductive material to form an electrical capacitor.

This method provides a 3-dimensional "trench" capacitor which has a surface area large enough to hold a substantial amount of charge, but which does not make a large "footprint" on the surface of the chip. By contrast, the more conventional planar structure occupies three times as much area for a given number of cells.

Opportunities for local industry in defence build-up

Electronic intelligence gathering and surveillance equipment are to get top priority under the Federal Government's recently announced defence equipment program. The Government proposes to spend $25 billion over the next 15 years on capital equipment and new facilities in pursuit of a self-reliant defence policy.

According to the Minister for Industry, Technology and Commerce, Senator John Button, the defence build-up will provide substantial opportunities for Australia's engineering, shipbuilding, electronics and aerospace industries.

Early warning aids are to get priority under the new program, with the Government set to acquire three Jindalee over-the-horizon (OTH) radar systems at a cost of some $500 million. These systems will be backed up by airborne early warning (AEW) aircraft and a new satellite intelligence station to be built in Western Australia.

The new satellite station, unlike the joint facilities shared with the US at Pine Gap and Nurrungar, will be wholly controlled by the Defence Signals Directorate. At the same time, new communications are being developed to give defence headquarters in Canberra instant access to data from the joint facilities.

Other developments of significance to the electronics industry include updated avionics for the 23-strong F111 strike force, new sensors for the P3C Orion maritime patrol aircraft, and weapons systems for six new submarines and eight new light patrol frigates. The Government is to consider fitting the new ships with long range cruise missiles for land attacks.

Anti-submarine warfare capabilities will be enhanced with the delivery of Seahawk helicopters and the development of a towed acoustic array for tracking submarines. A mine countermeasure force of at least six catamarans will be developed.

Finally, the range of the F/A18 Tactical Fighter Force will be greatly increased with the introduction of in-flight refuelling. To this end, four Boeing 707 aircraft will be converted for use as aerial tankers.

Free EA's for regular DSE customers

How would you like to get your copy of *Electronics Australia* FREE — every month?

You can — simply by shopping at Dick Smith Electronics! In an unprecedented move that's sure to be popular with hobbyists all over Australia, DSE has announced that it will give away a copy of *Electronics Australia* to all regular hobbyist customers.

"The definition of 'regular hobbyist customers' is largely left to the discretion of the store manager," said Mike Wilson, Managing Director of Dick Smith Electronics.

"But each store manager and his staff know who are the regulars — and we're rewarding those people. To establish yourself as a regular DSE customer isn't difficult — we're not talking about spending hundreds of dollars a month!"

"I'd imagine that anyone spending, say $70, a month would automatically qualify for the 'regular customer' title".

DSE also has other plans to reward its regular customers will be rewarded. In the future, special "regular customer offers" will be made — exclusive to our regulars customers only.

The free *EA* offer starts with this (May 1987) issue. If you're a regular customer and you've borrowed someone else's copy, race into your nearest DSE store and they'll give you a copy of your own!

Philips proposes compact disc video system

Philips of the Netherlands and Sony Corporation (Japan) have proposed a new compact disc format to Japanese and US software producers. The new format, called CD-V or compact disc video, will have 25 minutes recording capacity — 20 minutes for digital music on the inner tracks and five minutes of audio and video signals on the outer tracks.

A special CD-V player will be required to decode the video content of the discs, although the audio portion could be played back on existing CD players. The new disc will be golden in colour to distinguish them from standard CDs.

Philips and Sony have also announced plans to jointly develop specifications for a CD audio single. According to a recent press release, the two companies are currently considering a 7.5cm disc capable of carrying 20 minutes of music and compatible with current CD players by means of an adaptor.

Long play videodisc player developed for high-definition TV

Engineers at Toshiba Corporation in Japan have developed an advanced videodisc player that meets high-definition TV (HDTV) requirements. The new system features a total playing time of 1.5 hours, the longest time so far achieved for HDTV optical type videodisc players.

The HDTV (High Definition TV) system developed by NHK (Japan Broadcasting Corporation) is expected to form the basis for the next-generation TV broadcasting system. Current NTSC systems as used in the US and Japan (but not Australia) use 525 scanning lines per second. The HDTV system has 1,125 lines — more than twice as many.

The big advantage of HDTV is that it is capable of excellent picture quality — surpassing that of 35mm movie images on a full-sized screen. Furthermore, the quality of sound reproduction is much higher than today's current TV systems and the aspect ratio of the screen has been increased from 4:3 to 5:3.

Unfortunately, current video equipment, including VCRs, TVs, cameras and transmitters, will not be compatible with HDTV.

Subscription winner

The winner fo the special subscription offer which was run over the last three issues is Mr I. Adamson of Mitchell Park, South Australia. Mr Adamson has won a Daihatsu Charade. Our photo shows Mr Adamson at right receiving the keys from Ron Bragg of Daihatsu Australia (centre) and Geoff Baggett, General Manager of Federal Publishing.

New developments in flat screen TV

Several new large-screen colour liquid crystal displays suitable for use in colour TV receivers and computer monitors have recently been announced by Japanese researchers.

Leading the pack is a new 36cm (14-inch) display from Seiko Instruments and Electronics. Although impressive, the new display is not yet ready for production, largely because some of the equipment required to mass produce it is still under development.

Much the same comment applies to other Japanese companies that have developed LCD colour panels. These companies include Matsushita with a 32cm display, Mitsubishi (25cm), Hoshiden Electronics (18cm) and Hitachi (18cm).

When will we see large flat screen displays in colour TV sets? That development is still some years off and is dependent upon improvements to such things as brightness, contrast and reponse speed.

News Highlights

Sony's stunning new portable CD player

Sony has announced the release of a stunning new portable CD player that's barely larger than the discs it plays. Called the *Discman D-100*, it is 80% smaller than the first portable CD player released by Sony. Dimensions are just 125.8 x 132.8 x 19.8mm.

The Discman D-100 has all the features of the original D-50 and D-50 MkII versions and includes automatic music sensor, two-speed search function, music repeat and random track programming. The latter enables programming of up to 21 individual tracks in their preferred order. A large liquid crystal display shows the various operating modes.

To cope with shock or vibration, the D-100 has an in-built track memory, which will return to the precise playing position after being knocked or bumped. The new player is suitable for use as a personal portable or in the car.

A rechargeable battery pack is supplied as standard with the D-100 and there is an impressive list of optional extras, including infrared remote control and a car cassette adapter to connect the unit to most car stereo systems.

The Discman D-100 is now available through the Sony dealer network and carries a recommended retail price of $699.00

Speech recognition for cars of the future

Imagine being able to talk to your car — and have it respond. The fact is, speech recognition devices could well play an important role in the vehicles we'll be driving towards the end of the century.

Recently, Renault displayed a prototype vehicle that accepts spoken commands for a range of non-critical accessories — things like windscreen wipers, heater and air conditioning, windows and the radio. Before the car can respond to your commands though, you must initially train the voice recognition circuitry by repeating each command several times.

Another area where voice recognition technology is likely to gain increasing use is in cellular car phones. Already, there are several add-on devices available on the US market that allow voice dialling.

Head-up display for car dashboards

Used successfully in aircraft for many years, head-up displays are now being considered for use in motor vehicles. One such system has been developed for the Ford Motor Company by researchers at Battelle Laboratories in Ohio.

In the head-up display (or HUD), a cathode ray tube projects visual information onto a holographic mirror embedded in the windscreen in front of the driver. This mirror reflects the blue-green light from the CRT back to the driver's eyes but is transparent to all other colours so as not to impair the driver's view of the road.

The result is an image that appears to be suspended in mid-air in front of the windscreen. The main advantage of the system is that the driver need never take his eyes off the road to look at dashboard instruments.

Redesigned booster joint for space shuttle

With test firings of redesigned booster rockets for the Space Shuttle scheduled for later this year, worries have surfaced in NASA that Challenger may have been lost because of severe wind shear.

According to investigators, the wind shear encountered by Challenger some 60 seconds after blast off were the most severe experienced on any shuttle flight. Although the accident report suggested that hot flames leaked from the booster due to faulty O-ring seals, it is also possible that the violent wind conditions may have been responsible for re-opening the flawed joint.

Morton Thiokol, the company that manufactures the shuttle's solid fuel booster, is to begin initial test firings using the old joint, but with new sealants and materials for the O-rings. Following these tests, the company plans to test a stronger but more complex joint which should clear the shuttle for lift off again next year.

Breakthrough heart pacemaker

The Australian heart pacemaker company Telectronics has scored a major coup with the development of a new type of heart pacemaker.

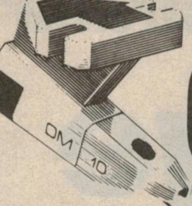
Called the Guardian pacemaker-defibrillator, it is the first implantable device to pace the heart when it beats too fast or flutters. Conventional pacemakers, on the other hand, work to monitor and regulate the heart when it beats too slowly or irregularly.

The device works to prevent the heart from beating too quickly by firing a series of micro-shocks. If this proves unsuccessful, a single strong shock is fired across the heart to break the fast beating pattern in much the same way as doctors use external shock paddles to revive patients in the defibrillation process.

If need be, the device can be reprogrammed after implantation by RF signals. Several hundred of the new units, which cost about $15,000 each, will be implanted in Australian and American patients over the next few years.

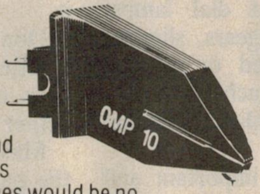
In other moves, Telectronics recently became the world's second largest heart pacemaker manufacturer when it agreed to buy the pacemaker arm of the UD Cordis Group. The acquisition of Cordis should greatly strengthen Telectronics' position in the US pacemaker market.

CAPTURE AN ORTOFON OM-10 FOR ONLY $89* AND ESCAPE TO DENMARK WITH SAS



Now is the time to update your Hi-Fi system with one of ORTOFON's superb OM/OMP cartridges.
By doing so, you will also have a chance to go to Denmark and visit the ORTOFON manufacturing plant.

WHY THE ORTOFON OM/OMP SERIES CARTRIDGES?



If we were to take away their high output, adjustable mass, diamond quality, superior sound and stylus interchangeability, these cartridges would be no different from all 'the others'.
But with all these features and their sonic excellence, these cartridges have become the most successful range of cartridges ever produced by ORTOFON. In terms of value for money the OM-range is now recognised throughout the world as "the one to buy".

WHAT THE EXPERTS SAY!

GRAMOPHONE: "...the OM-20 showed a more solid bass and midrange and freedom from edginess." "...The OM-30 had a more subtle sound quality with greater clarity and definition, a more positive stereo image."
HIGH FIDELITY: "The OM-40 is the best magnetic cartridge that this Danish manufacturer has ever produced..."
HI-FI CHOICE: "ORTOFON OM-10...BEST BUY!!"
The nomenclature "OM" stands for Optimum Match. By removing the in-built 2.5 gram weight-plate, the OM cartridges can be perfectly matched to any medium or low mass tone arm. The technically identical OMP models are designed for use in P-mount tonearms.
All OM styli are interchangeable. If your budget does not allow the top model initially, start with the OM-10 and update the stylus later.

THE PRIZE LIST

Buy any ORTOFON OM/OMP 10, 20, 30 or 40 cartridge between 1st March and 30th June 1987 and you could win one of the following prizes:

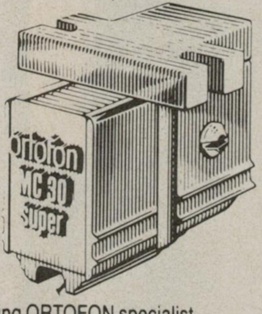
1st PRIZE:
7 days holiday in Denmark. Flying with SAS, The Businessman's Airline, to Copenhagen and return, including 6 nights first-class hotel accommodation and all transfers.
This exciting trip includes a visit to the Ortofon manufacturing plant, plus an opportunity to visit the Danish Royal Theatre, famous Tivoli Gardens and one of the many famous Danish jazz clubs.

SAS

THE BUSINESSMAN'S AIRLINE

Next time you travel to Europe on business, why not give yourself a break and fly SAS, the Scandinavian way – one stop to Copenhagen, the business heart of Europe.

2nd PRIZE:
Ortofon MC30 Super Moving Coil Cartridge. Valued at $800.



3rd PRIZE:
Ortofon MC20 Super Moving Coil Cartridge. Valued at $600.

Full details and conditions of entry from your participating ORTOFON specialist.

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Preserving Australia's radio heritage

Vintage radio restoration Pt.2

Last month, we looked at some of the essential aspects of getting an old valve radio functioning again. This advice mainly concerned replacement of various electronic components, but repairs to mechanical parts and to the cabinet are also often required.

by JOHN HILL

Dials are one such mechanism and are a constant source of trouble to vintage radio restorers. Dials can vary from relatively simple units driven by a cord, to more complex gear and friction drive types. All require a full strip down, clean and assembly job if they are to run smoothly again.

Common problems encountered with old radio dials are: broken dials or cover glasses, burnt out dial lamps, broken cords, gooed up gears, slipping friction drives and rusted or missing parts. There is usually much more to a dial repair than simply replacing the dial cord.

Cleaning dial parts is important and to do the job properly requires a brush and kerosene. If the parts are carefully cleaned and re-assembled with a drop of oil or a dab or grease, the mechanism will operate smoothly once again.

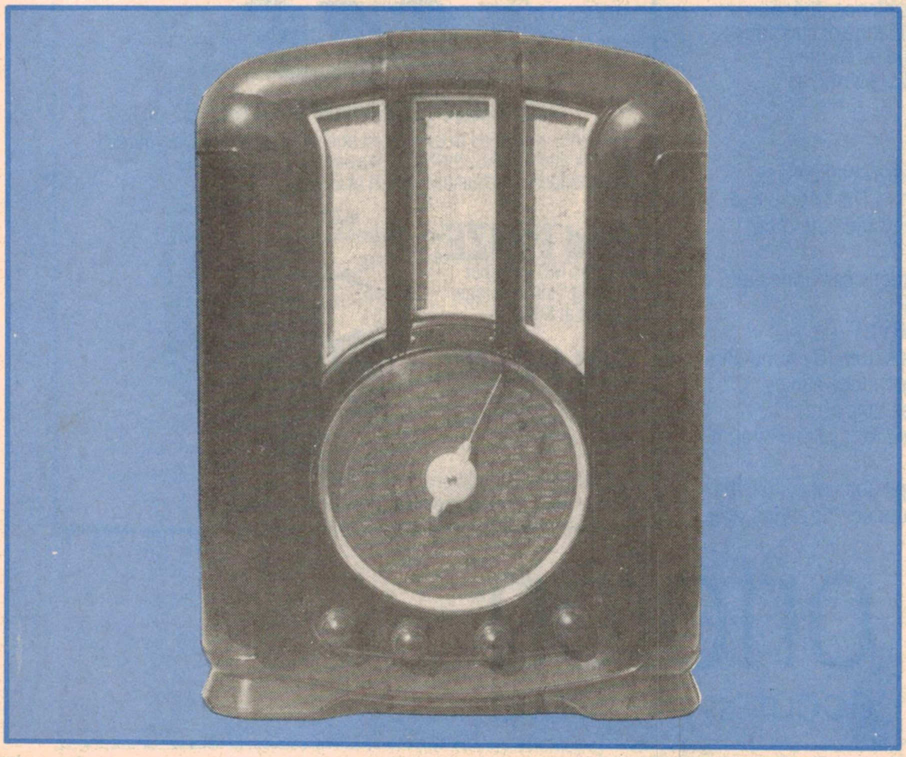
Some old dials are remarkably complicated. They have pulleys, cords, gears and even flexidrives to iron out misalignment between the dial mechanism and the tuner. It is therefore advisable to make a detailed sketch of the complete assembly before dismantling it. It doesn't have to be an oil painting, any rough old sketch will do. You are the only one who needs to understand it.

Don't rely on memory alone because it often doesn't help much when the time comes to put all the pieces together again.

Make sure that a dial sketch includes the path of the dial cord because some cord layouts are most involved and a sketch of the cord set up is indeed valuable. If the cord has broken it makes that task more difficult, but even with a broken cord, it is often possible to make a sketch of where the cord ran before it broke.

To give an example of the complexity of some dial set ups, I have an old 1939 Airzone five-valver that has the most elaborate dial mechanism I have so far encountered. It took approximately four hours to do the dial job, simply because there are so many bits and pieces.

For a start, there is the normal cord from the tuning knob spindle to the drum that turns the tuning condenser through a 2:1 gear reduction that is complete with backlash eliminator. The reason for the gear reduction is because the dial pointer rotates through 360 degrees, while the tuning condenser only turns 180 degrees. Such a set up was common on radios of the 1930s. In addition, there is a flexidrive unit, several backing plates and support brackets, at least a dozen nuts, bolts and spring washers, plus the dial assembly itself with its protective cover and dial lamps.



This 1939 Airzone has a complicated dial mechanism consisting of 150 individual parts.

In all, there are 150 individual parts just for the dial mechanism!

Whilst the Airzone dial looks impressive, it is nevertheless a little over engineered for the job. When compared to a modern transistor radio with a tuning knob on the end of the capacitor shaft, the Airzone setup is unnecessarily complex.

Glass dials

Most dial glasses require attention and they usually need cleaning on both sides. Needless to say, the side of the glass which carries the station markings must be cleaned with care — great care!

The station call signs were usually placed onto the glass by using a transfer, although a stencil may also have been used in some instances. Some station markings are so tough, the dial can be washed under running water and dried with a towel. However, other dials are so fragile they cannot be touched with anything, otherwise the stations just wipe off the glass.

There are dials that really are this delicate and even a gentle rub with a cotton bud will instantly remove the station markings. The paint used to mark old dial glasses seems to degenerate with age into a powder-like substance which is easily dislodged.

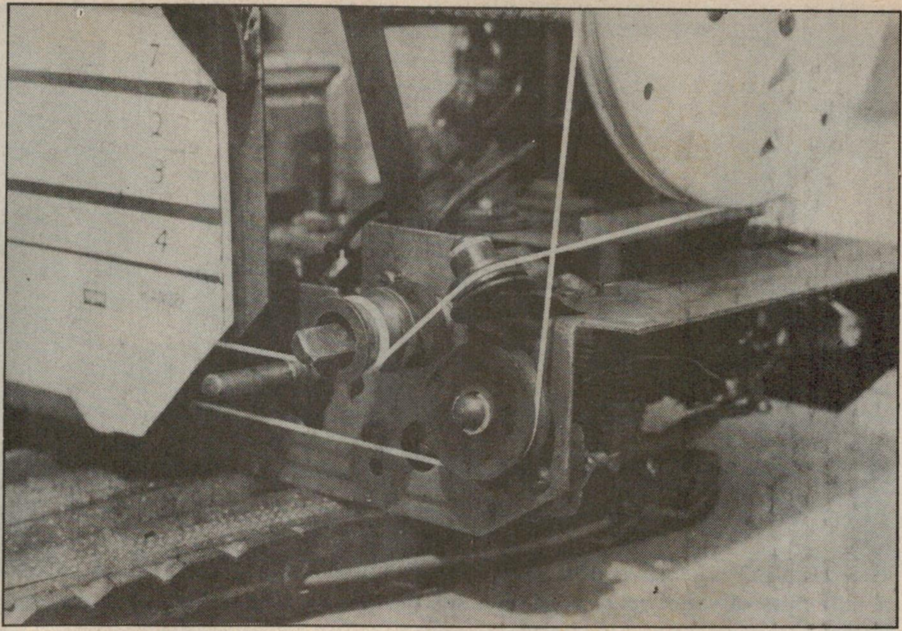
Not all dials are so difficult to work with but considerable care must be taken when cleaning dial glasses, otherwise the dial might be ruined. Unfortunately, both sides of the glass must be cleaned to bring back that new look.

A touch of paint on the dial pointer also helps the dial to look new again. It is simple little things like that which make a restored radio look the part.

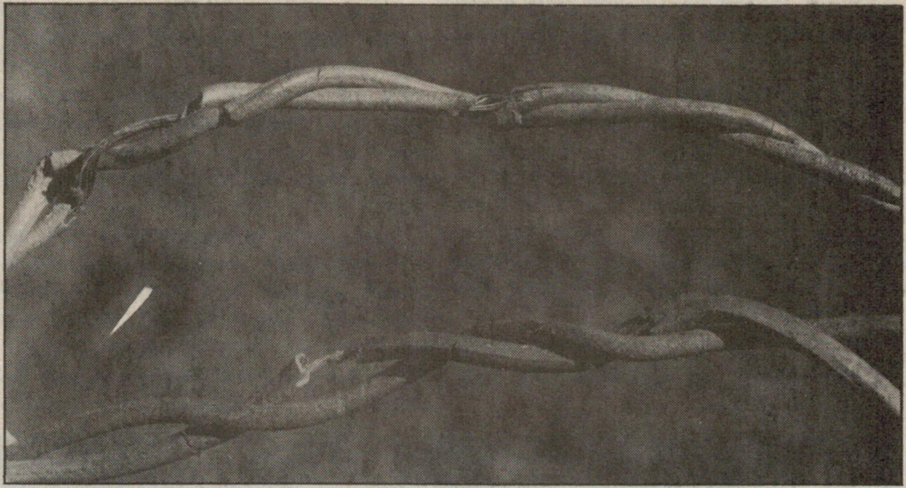
Many old radios have broken dial covers. Some covers are glass, while others are celluloid or like material. These dial covers often crack and discolour and replacement is the best way to go.

Although the majority of dial covers are shaped (not flat), a flat replacement doesn't look out of place and one wouldn't know the difference unless very observant. Let's face it: a flat, clean dial cord is better than a discoloured and cracked one, even if it is nicely shaped and contoured.

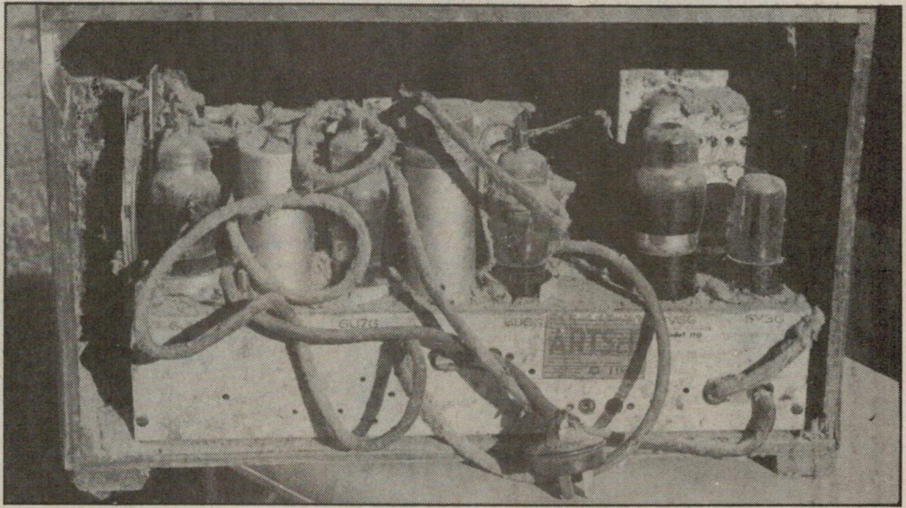
Glass is difficult to cut and, unless one has mastered the art of cutting it, acrylic sheet is a much easier material to work with. Acrylic is obtainable in many thicknesses and 2-3mm is ideal for radio dials. Once again, a replacement dial cover helps to give an old set that new look and a restoration can fail in its overall effect unless the dial is given the



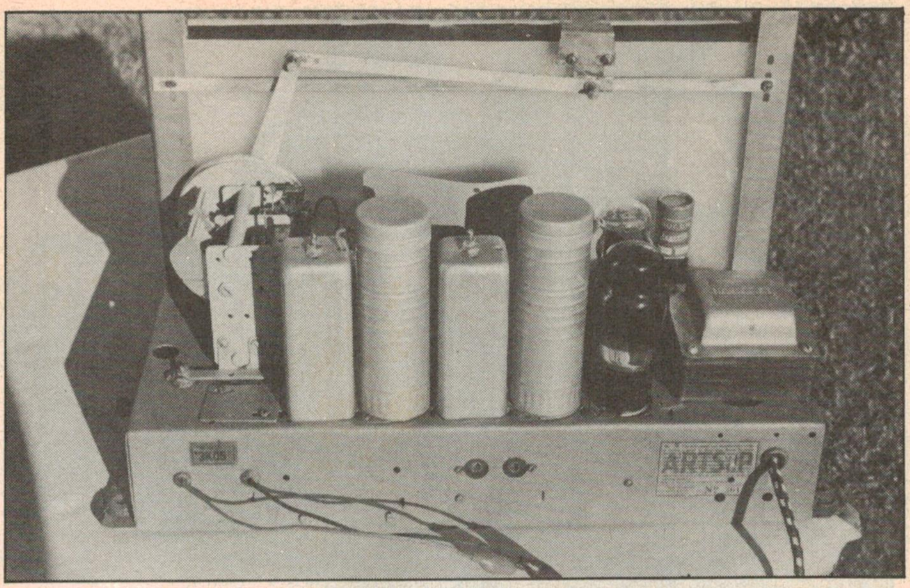
Dial cords can be difficult to replace. A layout sketch is a good idea that can save time and frustration.



Rubber covered insulation deteriorates with age. Replacement of such sections of wiring is most essential.



A typical valve radio prior to restoration. A good many hours of work is required to bring such receivers back from the grave.



A fully restored radio, ready to go back into the cabinet. Note crank used to move dial pointer.

full treatment. The dial is the focal point of the whole set and if it looks second rate, then the set will also look second rate.

The wiring of the dial lights is something that should also be checked for often the insulation has broken down and the low tension can short out on the chassis somewhere. Insulation breakdown is common when natural rubber has been used, for it becomes hard, cracks and falls off, leaving the wires bare and vulnerable.

Replacing dial globes while the dial is being worked on could also be a wise move.

Restoring the chassis

Valve radios are either fully open or partly open at the back (for cooling) and, as a result, dust and grime finds its way into the set. Cleaning away the dust and rubbish frequently reveals rust and other forms of corrosion on various components, including the chassis. This makes the set look quite unsightly.

Some parts polish up quite OK and the aluminium cans and valve shields usually respond well to the wire brush treatment. Retaining the natural aluminium look is better than painting over the top of it. However, the chassis and other steel components are inclined to rust and require some form of paint work to enhance their appearance.

It is here that the radio restorer must decide whether he will leave the set in its original condition or touch it up with a coat of silver frost or whatever.

In some cases, the original surface cleans up quite well and can be rejuvenated by lightly rubbing with a lint free cloth dipped in the touch up paint. A touch up of this nature is often more appropriate than a complete repaint job for it looks clean and tidy, but not that new looking that it has obviously been repainted. One could perhaps reduce the value of an old radio by over doing the paint brush routine.

Loudspeakers

Old loudspeakers can also give their share of trouble and some are in a sorry state to say the least.

The most common problem is a torn or damaged speaker cone. Being made of paper, the cone is easily damaged and most old speakers have a rip or two in them somewhere. Even silver fish eat holes in speaker cones.

This type of damage can be repaired by gluing the rip together again and "Silastic" or similar seems an ideal repair agent for sick speaker cones. Silastic adheres well to the paper and is quite flexible if it needs to flex. Whilst there may be other effective means of fixing speaker cones, Silastic is quick, convenient and appears to be long lasting.

One way out of speaker trouble is to simply fit a modern speaker of similar size but, once again, this ruins the originality of the set. Whether this is important or not is up to each individual collector.

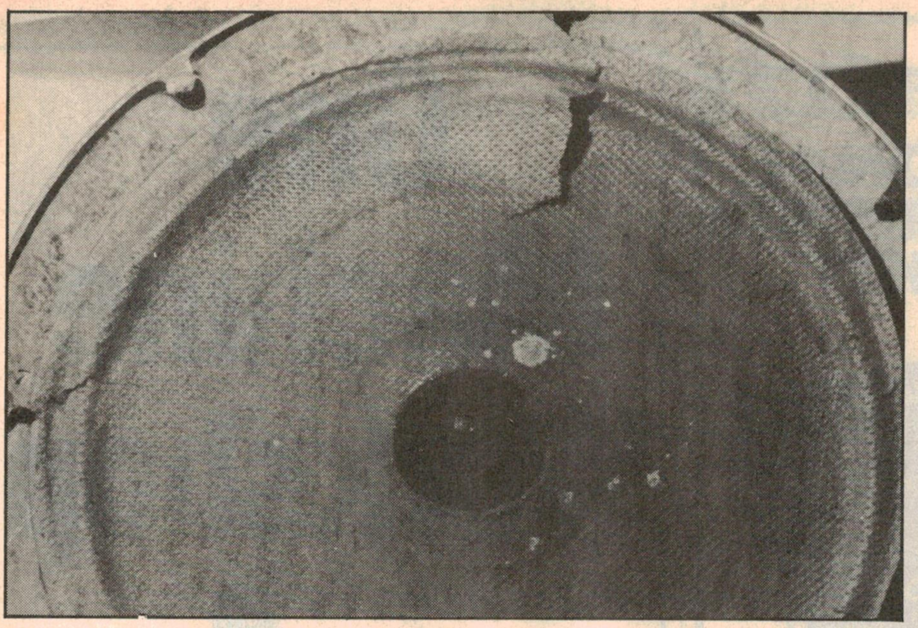
Personally, I strive to keep my sets as original as possible and if a speaker has to be replaced, it is usually replaced with a similar speaker. Electrodynamic speakers offer greater problems in this regard, and an exact replacement is not always possible.

Electrodynamic speakers come in two varieties — reasonable ones and terrible ones. There is also a third type; they are the ones with burnt out field coils that don't work at all.

If a speaker gives a poor reproduction, which isn't uncommon with electrodynamics, it can be replaced with a permanent magnet speaker, although there is a bit more to it than that.

When switching from electrodynamic to permanent magnet, there is a little matter of the field coil which must be retained in some form or other. The field coil is the high tension choke and it can be replaced with a separate choke

A small wire brush and a can of paint can help clean up a grotty chassis.



Torn loudspeaker cones can be repaired even when in this condition. "Silastic" does the job quite well.

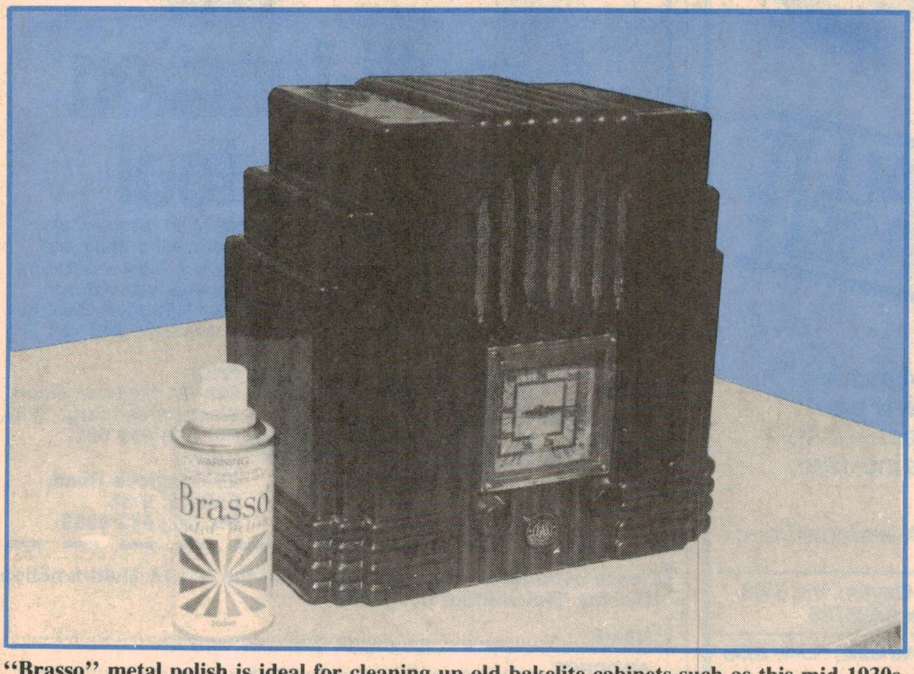
of the same impedance or a high wattage resistor. Even the original field coil can be used if it is detached from the speaker and placed in some inconspicuous part of the set.

Cabinet restoration

Depending on one's interests, a restorer may favour the radio repairing aspect of the hobby, or he may prefer the cabinet restoration side of it. Personally, I hate restoring wooden cabinets and only wish I knew someone who would do a good job for a reasonable price.

Restoring timber cabinets is nothing but a lot of hard work. The first step is to fill all the split and loose joints with a wood glue such as "Aquadhere" so as to tighten up the frame. Most old cabinets were glued together using animal glue (the old hot-pot technique) and, after four or five decades, the glue lets go and the cabinet becomes very rickety.

The next step is to fix any raised blisters or lifted sections of the veneer. Blisters are repaired by first cutting a slit in the them so as to get some glue inside. Once this has been done, the blister can be clamped and left to dry for 24 hours. A webbing clamp is a most useful tool for this purpose.



"Brasso" metal polish is ideal for cleaning up old bakelite cabinets such as this mid 1930s Radiola.

Then comes the loathsome job of scraping off the old varnish. In some instances, the varnish scrapes off easily because it has deteriorated with age and is only loosely attached to the surface veneer. When the varnish is more firmly attached, paint stripper is the best way to go.

When using paint stripper, it is a good idea to use it sparingly and not saturate the woodwork as there could be a long term chemical effect on the wood fibres. There are special "antique" paint and varnish removers available and it may be wise to use such products as a precaution.

After the old varnish has been removed, it is advisable to inspect the cabinet for dents and apply steam to those areas as it helps to swell the depression back to normal again.

Sand papering is next on the list and the more time spent smoothing out the surface, the better will be the final result. However, great care must be taken when sand papering because the veneer on the cabinet is less than 1mm thick and to sand through the veneer is to ruin the cabinet. Course sand paper should be avoided due to the depth of the scratches it produces.

When properly sanded and dusted down, the inside of the cabinet should be painted. Black or clear are the most common treatments and if the paint or lacquer is mixed 50/50 with turps, it will soak into the wood and produce a relatively flat surface finish.

Most old wooden cabinets were clear lacquered on the outside, with odd parts painted either black or chocolate brown so as to contrast with the rest of the cabinet. This is a very good effect and the easiest way to reproduce it is to do the paint work first, then lacquer over the lot.

The lacquer can be applied using either a brush or a spray can, depending on available equipment and the quality of the finish required. If using a brush, the brushmarks can be smoothed over with 1200 grade wet and dry paper after the lacquer has dried. An ultra thin coat of Scandinavian oil applied to the surface will add a semigloss effect. A few follow up coats of oil will further enhance the surface finish.

There are many ways of finishing a wooden cabinet; none are easy and all take hours of scraping and sanding. Of course, the more cabinets one does the more proficient one becomes. Doing

cabinets in twos or threes can save time if a mass production approach is preferred.

Plastic cabinets

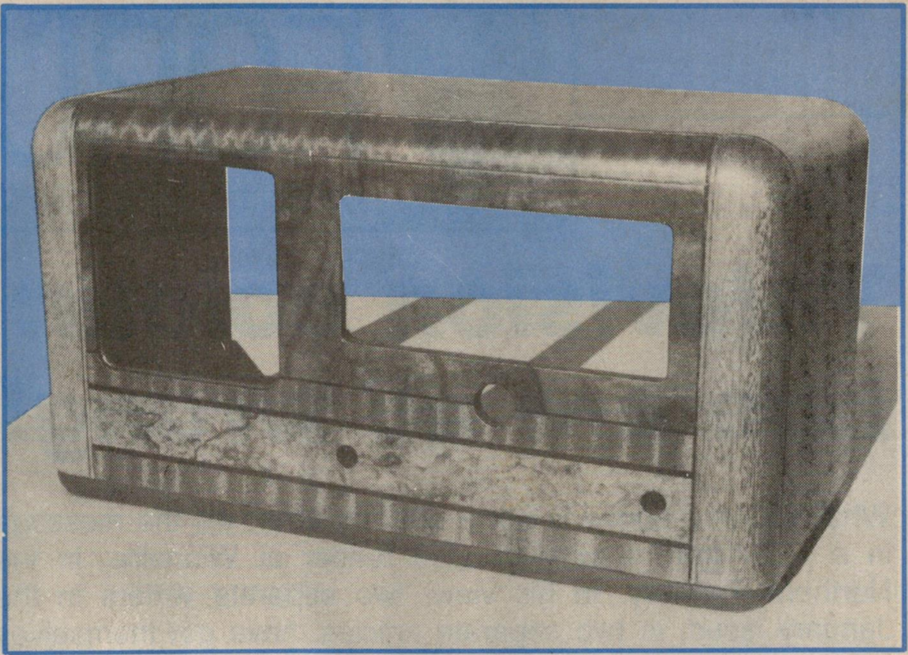
Plastic and bakelite cabinets are much easier to restore and about two hours work will see most of these cabinets looking shiny and new again.

A good starting point with a bakelite cabinet is a thorough scrub up with hot soapy water, both inside and out. A toothbrush and a small nail brush are useful for getting into awkward corners and deep grooves.

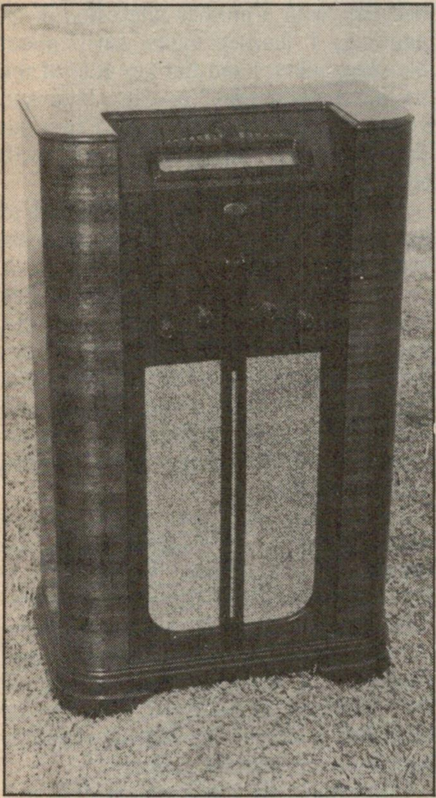
When clean and dry, check for any cracks or splits and, if there are any, repair them with a drop of super glue. Now comes the hard work.

The dull finish on the cabinet can be completely brought back to new by a hard rub down with "Brasso" metal polish. A hard rub means just that. What's required is plenty of Brasso, a firm pressure and an hour or so of rubbing. If sufficient effort is put into the job, bakelite and plastic cabinets will shine better than new.

Deep scratches can be a bit of a problem and they require a lot of pressure and rubbing to make them fade just a little, Perhaps gentle use of fine wet and dry paper could help in some instances, but the colour and texture of the material may change if rubbed down too deeply.



This HMV cabinet combines several contrasting timbers. They don't make them like this any more.



Timber cabinets, as used for this old Airzone, require a lot of work to restore them to their former glory.

The "Brasso" treatment is also ideal for the control knobs and these too can be made to shine as if they were new. Special care must be taken to clean the knobs before polishing and a scribber point and toothbrush are handy tools for digging out the rust and grime that settles in the grooves over a period of time.

"Brasso" is truly a wonder treatment for many old radio parts and another bit that responds well is the plastic dial cover that so many old radios have.

Dial covers appear to be made of either celluloid or cellulose acetate, the difference being that celluloid discolours to a yellowish tint, whereas cellulose acetate remains clear. However, as both materials are soft plastics, they scratch easily and, over a period of time, become almost opaque. Careful rubbing with a soft cloth and "Brasso" will polish away the scratched surface and restore the dial cover to as new condition once again.

Great stuff, that "Brasso"!

Conclusion

As the author of these valve radio restoration articles, I hope that I have inspired some readers to do something about Grandpa's old radio that has been in the shed for the past 20 years.

If you have a valve radio, you will find that restoration is an interesting and rewarding experience that will produce a very good radio set. If you don't wish to restore the set, then pass it on to someone who does. Whatever you do, don't dump it. Once that happens, that particular example of radio history is lost forever.

FORUM

Conducted by Neville Williams

Television colour: hue are all wrong!

What you see above is not a spelling error; it's the message in a letter from a very puzzled reader at Winnellie, in the Northern Territory. In his view, two separate writers in the January issue, in two separate articles, have got themselves into a complete tangle in respect to the so-called primary colours.

In actual fact, if the writer had been able to check back over the past issues of this and other publications, he would have found the same supposed inconsistencies repeated many times over, right back to the days when David Sarnoff virtually staked the future of RCA on the development of electronic colour television!

I reproduce the letter substantially in full, because it reflects the degree of the writer's confusion and raises matters which, I tip, may have puzzled other readers over the years.

Dear Sir,

I feel I must take you to task regarding the articles in the January 1987 issue entitled: "The Big Screen at the Big Match" by Terry Ayscough and "Understanding Colour Television" by David Botto. I have read both several times but am still confused as to how the various colours are produced on a colour TV screen — particularly in respect to the choice of green as one of the colours used to produce the rest of the spectrum.

One of the articles contains two definite errors.

I would have expected colour TV to use red, yellow and blue, which are the three, and only, primary colours. Other colours are a combination of these three. I was therefore surprised to find, not yellow but green used as one of the basic colours and I have yet to see a clear explanation of how yellow can be produced on a TV screen.

In the second article under the paragraph heading "Colour mixing", it says: "Colour mixing using three properly selected primary colours . . . &c". As there are only three primary colours, all of which have to be present to produce the full spectrum, what is there to select?"

Regarding the errors mentioned above: in the first article, under the paragraph headed "Picture elements", it states: "Each picture element or pixel thus consists of two green, one red and one blue primary coloured dot." Here the two articles are contradictory because the second article states that a primary colour cannot be produced by mixing any other colours. Therefore green, which is a mixture of yellow and blue cannot be a primary colour.

The article goes on: In the additive mixing process, non primary colours such as yellows..&c. As yellow cannot be produced by mixing any other colours, it is and always was one of the three primary colours. Mixing red and green as the article states would produce brown, not yellow. Hence my confusion; to produce yellow from green, the blue component would have to be deleted, not another colour such as red added.

Returning to the second article under "Colour mixing . . . If we subtract red light from white light . . . &c." White is the combination of all the colours of the spectrum but, for simplicity, I will assume that the white referred to is a combination of the three colours red, yellow and blue. Removing any one of these colours will not leave just one but a mixture of the other two. Remove red and you have green; remove blue and you have orange; remove yellow and you have purple. None of these resultant colours are primary.

I feel sure that this letter will not be the only one you receive regarding this subject, so perhaps the matter can be discussed in "Forum". Perhaps someone has a better explanation of how colour is produced in colour TV.

In closing, I would like to register my appreciation of your magazine. I look forward to its arrival each month.
B.D. (Winnellie, NT).

I can understand B.D.'s perplexity because, with a mother interested in oil painting, I learned quite early about blending colours and the key role of the so-called "primaries" — red, blue and yellow. Like many other kids, I first put the knowledge to practical use with school watercolour sets.

Much later I, too, was astonished to learn that colour television relied on red, blue and green.

My problem then, and presumably B.D.'s problem now, stems from the need to widen considerably what have been described — perhaps unfairly — as "artist-based" ideas about colours and colour mixing and, in the process, to set straight a number of questionable terms and impressions.

In checking back over the subject, I came across a very useful survey of colorimetry in the book "Colour Television with Particular Reference to the PAL System" by G.N. Patchett, Fellow of the Royal Television Society and Professor of Electrical Engineering at the University of Bradford, UK. He, in turn, lists a number of historic research papers on the general subject.

Confirming the statements in EA and at complete odds with B.D.'s firm assertions, Professor Patchett makes the following points (my summary):

(1) There are no "unique" primary colours.

(2) Any three colours can be considered as potential primaries for 3-colour reproduction, "provided that any one of the colours cannot be produced by the other two". This means, in effect, that they must be adequately dispersed within the spectrum.

(3) Some hue ranges are obviously more successful as primary colours than others but the exact shades within these preferred ranges "may, and do, vary with different processes".

(4) A well chosen set of primaries may be capable of producing a wide and satisfying range of hues but some colours may still not be reproduced with complete accuracy.

(5) Depending on the medium — pigments, coloured lights, etc — colour mixing may be an additive or a subtractive process, or even a combination of the two. The respective systems are essentially complementary, with different sets of optimum primaries, often described as complementary colours.

In the light of the above, B.D. will clearly need to rethink his assertion that there are three, and three only, unique primary colours, not subject to selection, and that they blend only in the manner with which he is familiar.

Fairly obviously, his ideas relate to traditional colour media such as paints, pigments, dyes, inks and filters, and to "subtractive" mixing, as mentioned in David Botto's article. All of the above absorb a range of hues from incident white light, reflecting a particular hue back to the eye, which we accept as the colour of the ultimate blend.

But, here, another matter needs to be sorted out. In the context of subtractive mixing, three colours are commonly accepted as being appropriate or near optimum primaries, best identified by the common names: yellow, cyan and magenta. Unfortunately, because cyan looks rather like blue, and magenta rather like red, they have been so misnamed in countless publications — thereby misleading countless readers, including B.D.

Referrring to subtractive mixing , Professor Patchett says:

This method of mixing is, of course, that used by artists and, for this reason, the colours yellow, cyan and magenta (wrongly called yellow, blue and red) are sometimes called "artist's primary colours". Often, and quite incorrectly, the word "artist" is omitted, causing some confusion.

Whether artists or house painters have much use of the "official" subtractive primary colours is another matter. It is more likely that they will create the shade they want from the assortment of colours available to them: a dab o' this and a dab o' that! But, when we're trying to sort things out, it does help to get the terminology right!

Additive mixing

As distinct from the above, colour TV uses what is known as the additive system of colour mixing, in which multicoloured patterns or pictures are composed from tiny adjacent discrete areas of primary colour(s), occasionally illuminated by white light but most commonly self-luminescent.

(Colour pictures in magazines are something of a hybrid additive/subtractive mix, because the individual colour dots tend to be separate in lighter areas but to merge or overlap elsewhere.)

With colour television, the elemental areas are normally self-luminescent and reliably discrete so that, for all practical purposes, television represents a pure additive system, with each tiny primary colour element in the picture contributing separately and directly to the perceived colour image.

As it turns out, the most appropriate additive primaries are red, blue and green and, over the years, the television industry worldwide has invested a great deal of time and effort in standardising hues which will produce a visually acceptable result and be optically efficient in terms of practical picture tube phosphors. Approximate wavelengths are: red, 615μm (micrometres); green, 532μm; and blue 470μm.

With these primaries and the highly flexible brightness control available with a cathode ray tube display, television can offer a wider range of hues than most other 3-colour systems, along with white, with all three colours suitably balanced and activated, black with the colours turned off, and intermediate greys and pastels.

Complementary colours:

Patchett offers a series of diagrams which emphasise the complementary nature of the two sets of primary colours — subtractive and additive. For example, yellow and magenta filters (or pigments, &c) in subtractive combination pass (or reflect) white light minus blue and green, resulting in red — which is equivalent to activating red luminescent phosphor elements, thus:

$$Y + M = W - B - G = R$$

Similarly:

$$Y + C = W - B - R = G$$

and

$$C + M = W - R - G = B$$

where Y = yellow, M = magenta, C = cyan, B = blue, G = green, R = red and W = white.

This is broadly what B.D. was struggling with towards the end of his letter, except that he was being misled by the longstanding confusion between magenta/red and cyan/blue, and his failure to distinguish properly between the two entirely different forms of colour mixing.

Incidentally, I omitted the final sentence from the earlier boldface quote from Patchett's book because, at that stage, it would have been a giant red herring (not a magenta one) in the dis-

Soldering Fumes: A Hazard?

Dear Sir,

Reacting to the query by K.Q. in the October issue of "Electronics Australia", I had a quick look at the information on the possible ill effects on health of working with solder.

The major recognised effect is one of occupational asthma, which seems to be due to sensitivity to colophony (pine resin) fumes. There have been several reports documenting effects of this type.

There has been a suggestion (I emphasise the word) that there may be an increased risk of spontaneous abortion in women working with soldering.

In a study of cancer morbidity of telecommunication workers, there was no overall increase in total cancer morbidity. An excess risk of malignant melanoma of the skin was detected, which seemed to be particularly associated with soldering.

Dermatitis has also been associated with soldering flux.

I would point out that the above effects were found in a literature search and the authors' summaries used without critical appraisal.

I trust that the information will be of interest.

Neill H. Stacey, PhD,
Senior Lecturer in Toxicology.

cussion at that point. The sentence read:

"It should be clearly understood that the true primaries are red, green and blue".

By "red", Patchett meant true red, not magenta; by "blue", true blue, not cyan. His statement fits in with David Botto's observation in the January issue of EA, p76, col.1:

"So the additive primaries of cyan, yellow and magenta are red, blue and green in that order".

But I guess that the key question is: does it work out in practice? If you need to be convinced, arm yourself with a strong magnifying glass or, if available, a jeweller's eyeglass and switch your TV set on at a time when you know that a test pattern is being transmitted. If the tube has vertical stripes rather than colour dots, so much the better.

Across the middle of the pattern, you will normally find a strip containing the colours, left to right: yellow, cyan, *green, magenta, *red, *blue, the three additive primaries being marked with an asterisk.

Examine the white areas and you should be able to see the three primaries, all glowing brightly. If the circuits in the receiver have been set up correctly, the white should have a very slightly bluish cast, similar to sky-scattered daylight — a subtlety that can really only be verified with test equipment.

Then look at the grey areas and note how the brightness of the colours diminishes progressively until they are barely visible, if at all, where the image is black. So far, so good.

But what of yellow, for B.D. the ultimate problem colour? Visually, the strip in the test pattern is visually less vivid than the rich yellows that often occur in actual program material but it will suffice. At viewing distance, the colour is undoubtedly yellow but close up, through the magnifying glass, there is no yellow to be seen — just the blue and green phosphors, glowing brightly, side by side.

"How can this be?" is B.D.'s implicit question.

The answer, broadly, is: "that's the way our eyes work!" Certainly, it's the answer in David Botto's article in relation to the subjective response to additive mixing. (Jan '87, p. 76):

When red and green light are projected on to the screen we see a yellow colour. This is because the cone-cells of our eyes are stimulated in the right proportions to produce a yellow sensation, even though no pure yellow spectrum light is present. Project green and blue and our eyes register a cyan colour. Red and blue projected together will appear magenta.

Perhaps I should add one further observation: when examining the primary or complementary colours on a TV screen, the redundant colour(s) may also be seen to be activated, even if only faintly. This could be because:

(1) There is some small error in the operation or adjustment of the receiver which is distorting the colours slightly, and/or

(2) The colours are less than fully saturated, with the third colour spiralling the hue in towards the pastel/white area.

Terry Ayscough makes specific reference to the reproduction of de-saturated hues on p.10, col. 1 of his article in the January issue.

To sum up, unless I have missed something, both articles emerge from the scrutiny completely untarnished. I trust that, having been alerted as to where his problems lie, B.D. will be able to rethink what is admittedly a rather confusing subject and to accept that he is not, after all, watching and enjoying an "emission impossible"!

A couple of teasers

While B.D. is sorting out his particular problems, here's one for those readers who fancy themselves as photographic gurus:

The quote from David Botto's article, a few pars back, carries the strong implication that the perception of yellow with additive mixing is a subjective effect. Stimulate the cones with a suitable mix of red light and green light, he says, and the eyes see yellow, even if no pure spectrum yellow is present.

That caused me furiously to think because, if and when I point my camera at a TV screen and set the exposure at 1/25th second or more, I will normally be rewarded with a reasonable facsimile of the TV image — yellow included. But my camera is a very non-subjective object and is normally loaded with colour film which employs subtractive mixing.

What permutations and combinations of the physics and chemistry of photography are involved in the creation of a slide or a print which can present to my eyes yellows which presumably did not exist in the first place?

Ducking the question myself, I rang my erstwhile assistant editor Phil Watson, who can usually be lured into any discussion to do with photography. But, instead of settling down to the speculation about resolution, the colour bandwidth of phoshors and film layers, etc, he was all set to head off for the south coast and the surf.

He reminded me that, somewhere back in the dim past, we had been involved in a parallel discussion about the true nature of opaque paints and pigments.

Someone had maintained that, in the ultimate, pigments were ground up particles of solid matter and, whether mixed dry or in a binder, they still presented to incident white light a surface composed of a jumble of discrete, differently coloured particles — the basis of additive mixing.

The counter argument was that the light penetrates into the mix and emerges after multiple complex reflections from the multi-coloured surfaces — therefore subtractive mixing.

At that point he chuckled and headed for the beach, leaving me with not one but two loose ends and all the incentive I need, at this stage, to change the subject!

Soldering fumes

In the accompanying panel is the text of a letter to hand from Dr Neill Stacey, of the University of Sydney, under the letterhead "Worksafe Australia", The National Occupational Health & Safety Commission.

It has to do with the possible harmful effect of soldering fumes, a matter first raised by a reader (K.Q., Chelsea, Vic.) in the October 1986 issue, and the subject of further comment by former staff member, Norman Marks, in February 1987.

While a case was made in the latter issue for exhausting suspect fumes, especially in the case of hand soldering, it would seem from Dr Stacey's letter that listed literature on the subject is rather sparse and tentative in the area of traumatic health risks. That doesn't mean that risks don't exist; rather that, if they do, they need to be verified and documented.

The matter remains open for further possible discussion.

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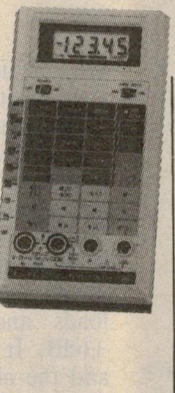

- 4½ digit LCD display
- True rms and data hold
- 8 functions, 0.05% basic Acc.
- Frequency counter

Vdc 0.2-1000V, 5 ranges 10uV max resolution,

Vac 0.2-750V, 5 ranges True rms

100nA max resolution, 0.75%

Ohm 200ohm-20Mohm, 6 ranges0.01ohm max resolution, 0.2%

Diode Testing

Buzzer for continuity Testing

Frequency: 20kHz, 200kHz, 1Hz max resolution, 0.5%

Accessories included: Testleads, spare fuse, Operator's Manual, battery.

$291.00

EDM-70B POCKET SIZED MULTIMETER

- Miniature
- Large LED display
- Audible continuity
- Toughened case

Vdc 0.2-1000V 100uV max res. 0.5%

Vac 200V, 750V 1mV max res. 0.75%

Adc 200u - 2A 0.1 uA max res 0.75%

Ohm 200ohm - 2Mohm 0.1ohm max res. 0.75%

Diode Testing

Battery Testing 1.5V/1.5mA

$64.40

EDM-1111A WITH CAPACITOR & TRANSISTOR TESTING

- 3½ digit LCD display
- Transistor hFE testing
- Capacitance measuring
- Toughened yellow industrial case

V dc 0.2-1000V 100uV max res. 0.5%

V ac 0.2-750V 100uV max res. 1.25%

A dc 200u-10A 0.1 uA max res. 1%

A ac 20m-10A 10uA max res. 1.5%

Ohms 200ohm-20Mohm 0.1ohm max res.

Diode Check

Continuity

Capacitance: 2nF-20uF

1pF max res. 2%

Accessories included: Test clips, spare fuse, Owner's Manual, battery.

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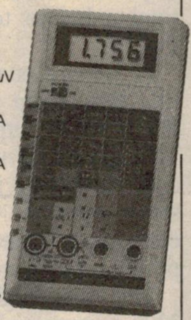
EDM-1116A



- 3½ digits LCD display
- Transistor hFE testing
- Capacitance measuring
- 8 functions, 0.5% basic accuracy

Vdc 0.2-1000V, 5 ranges 100uV max resolution, 0.5%

Vac 0.2-750V, 5 ranges 100uV max resolution, 1.0%

Adc 2mA-10A, 4 ranges 1uA max resolution, 1.0%

Adc 2mA-10A, 4 ranges 1uA max resolution, 1.5%

Ohm 200ohm-20Mohm, 6 ranges 0.1ohm max resolution, 0.75%

Capacitance 2nF-20uF, 5 ranges. 1pF max resolution, 2.0%

Transistor hFE, npn and pnp

Diode testing

Continuity Buzzer

Accessories included: Test leads, spare fuse, Operator's Manual, battery.

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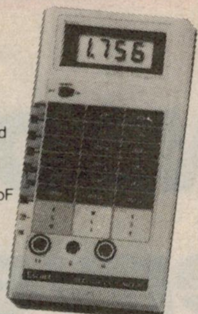
ELC-120 L/C/R METER



- 3½ digit LCD display
- Wide measuring ranges
- 3 inputs: Hi, Lo & Guard

RANGES —

Capacitance: 200pF-200uF, 7 ranges 0.1pF max resolution, 1%

Inductance: 2mH-200H, 6 ranges 0.1uH max resolution, 2%

Resistance: 20ohm-20Mohm, 7 ranges 10 10Mohm max resolution, 1%

Accessories included: Test clips, spare fuse, Instruction Manual

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Vdc 200V, 1000V (+0.5%) 100mV resolution

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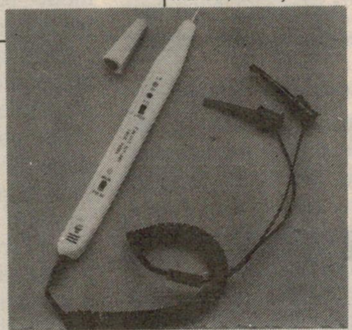

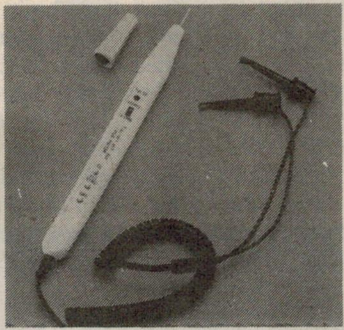

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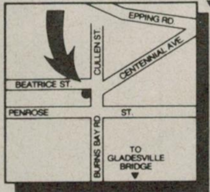

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NAD pushes the power envelope concept

For a number of years now, NAD amplifiers have been notable for their very generous headroom, or peak power capacity. Now, they have taken this concept further and are marketing amplifiers capable of a generous "power envelope".

Headroom is probably not the best term to use when describing amplifier performance. It refers to the amount of power which an amplifier can deliver for short periods, over and above what it can deliver on a continuous tone (sine wave) signal. The concept is legitimate though because rarely does real music contain long continuous tones but often has short transients which make big demands on an amplifier's capability.

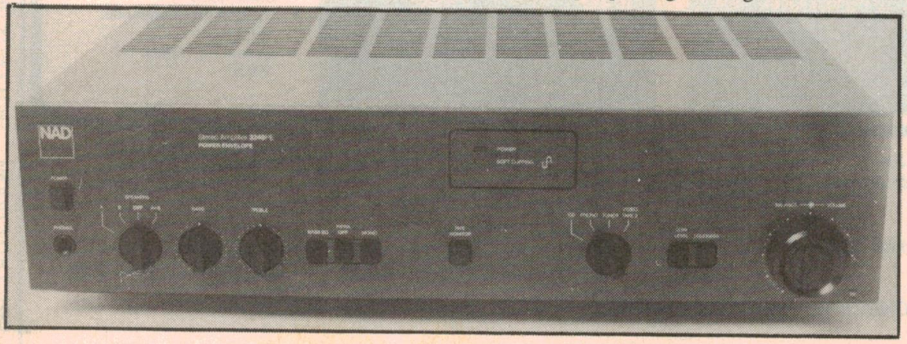
The standard test for dynamic headroom is set out in the EIA Standard RS-490 (formerly IHF-A-202) and involves a 20 millisecond tone burst of 20dB over a continuous 1kHz sine wave at intervals of 500 milliseconds.

One most amplifiers, this test yields a power output which is typically about 15 to 20% above the steady state power, giving a dynamic headroom figure of about +1 to +2dB. This reflects the fact that the power supply in most stereo amplifiers is reasonably well regulated. It also makes a lot of sense if amplifiers are designed to meet the American Federal Trade Commission's requirement of 40% power preconditioning before testing maximum power output.

A few years ago though, NAD saw that this design philosophy was limiting the power output on music signals. They came up with a way of dramatically increasing the power available for short musical transients without an equivalent increase in the amplifier's power supply ratings.

This was highlighted in the NAD 2200 power amplifier which was rated at 100 watts per channel on a continuous basis but had a headroom figure of +6dB which meant that it could deliver no less than 400 watts per channel on a short term basis. (The model 2200 has now been superseded by the higher rated model 2600).

NAD now state that they regard the above test for dynamic headroom as inadequate since the tone burst interval of 20 milliseconds is too short. Instead they are proposing a longer burst interval, of up to 500 milliseconds. They claim that this is more in line with the tone bursts in real music.



In line with this philosophy, NAD are designing their new amplifiers to deliver an extended "power envelope". The subject of this review, the NAD 3240PE, has a continuous power rating of 40 watts per channel into 8-ohm loads and a dynamic headroom of +6dB. It also features "soft clipping" and the ability to deliver peak currents of up to 25 amps.

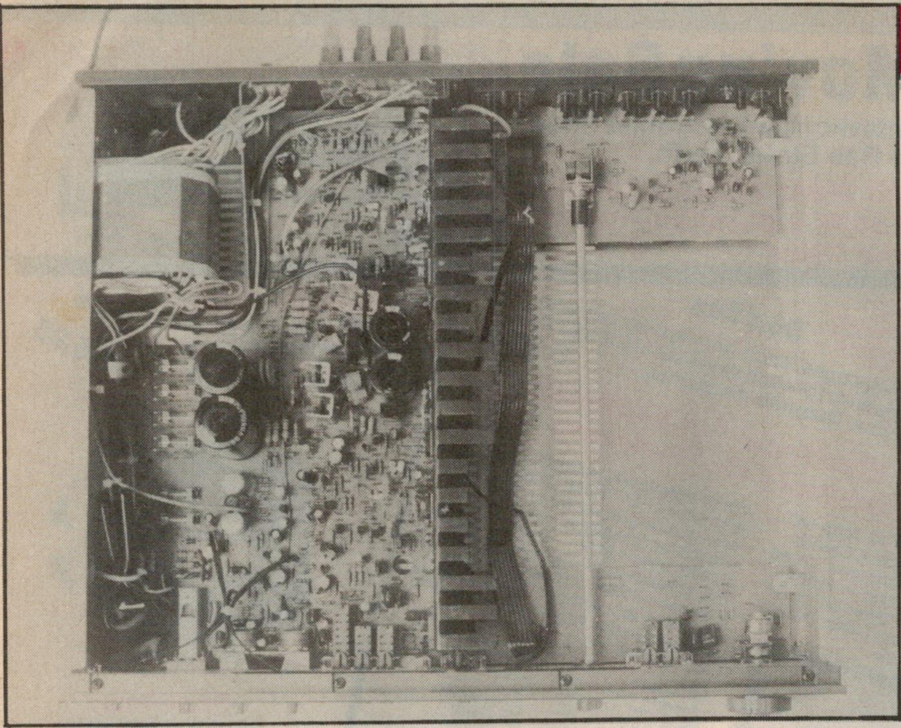
Main features

In appearance, the NAD 3240PE is nothing startling. Instead, its styling is very subdued, both in the charcoal finish front panel and the simple design of knobs and switches. That is not to say that the unit is short on control features — it is just that they are understated.

It has all the usual control features such as loudspeaker selector, bass and treble controls, tape monitor switch, input selector, muting (-20dB) switch and concentric volume and balance controls. As well, it has switches for mono mode (unusual these days), loudness, bass equalisation and infrasonic filter.

The last two are a little unusual. The infrasonic filter is just another name for a rumble filter although this one has a better chance of working since it has a slope of 12dB/octave below 12Hz. The Bass Equalisation switch gives a fixed boost of +6dB at 40Hz to compensate for the rolloff of many speakers at low frequencies. It should not be used in conjunction with bass boost or the Loudness control (we think that loudness controls have no place on a high fidelity amplifier).

On the rear panel, the NAD has the usual array of RCA sockets and a set of eight binding post terminals for connecting two pairs of loudspeakers. There are also two slide switches, one to bring the soft clipping circuit into action while the



NAD's 3240PE amplifier has complicated power supply circuitry to provide +6dB headroom

other is a loudspeaker impedance selector. The latter is locked with a screw into one of two settings: 8 ohms (high) or 4 ohms (normal).

This is almost a throwback to the old days of valve amplifiers when you had to select the output transformer secondary taps to suit the loudspeaker impedance. Usually, you had a choice of 16, 8 or 4 ohms. With the NAD, of course, there are no output transformers but the impedance selector changes the taps on the power transformer. The result is that the supply rails are slightly higher for 8-ohm operation.

Now this is an interesting concept but it does seem that NAD is having a bet each way.

On the one hand, switching to 8-ohm mode would give a slightly higher power output into 8-ohm loudspeakers. The 4-ohm mode would lead to a slightly lower dissipation in the output transistors under quiescent (no signal) conditions and also lessen the risk of transistor "second breakdown" when driving "difficult" (ie, very low impedance) speakers.

The question which must be asked is, "What happens if the user continually drives the amplifier hard into low impedance speakers when the high impedance mode is selected?" We did not attempt to put the question to a practical test.

"Soft clipping" is also an interesting concept and also harks back to valve amplifiers which had a softer clipping characteristic. NAD employs a clever circuit to accomplish it too although we would prefer the LED indicator to show when it acted rather than to show when it is selected.

Even more clever is the circuitry which allows the NAD to deliver high power for short periods. In effect, the amplifier has two sets of balanced (ie, positive and negative) supply rails.

The lower voltage rails supply the continuous power demand while the higher voltage rails are switched in when the amplifier senses that a high signal transient is occuring. If the amplifier is driven very hard for more than half a second, PTC (positive temperature coefficient) thermistors are used to shut down the high voltage rails and thus protect the output transistors from damage.

The concept is very effective, as our subsequent tests proved.

Performance

Our first tests were to determine continuous power output. These were performed with the impedance selector set to 8 ohms first, and then 4 ohms. In the first setting, the power output was 48 watts per channel into 8-ohm loads, 56 watts per channel into 4-ohm loads, and 48 watts per channel into 2-ohm loads. At the 4-ohm setting, the power was 37 watts for 8-ohm loads, 44 watts for 4 ohms and 55 watts for 2 ohms. With one channel driven, these latter figures rose to 49 watts, 62 watts and 70 watts, respectively.

In other words, as expected, the power output into 8-ohm loads is higher when the 8-ohm impedance setting is used. We also confirmed the rated distortion of the NAD at less than 0.03% for the above conditions.

We then performed the standard IHF headroom tests and achieved outputs of 190 watts per channel into 8 ohms, 310 watts per channel into 4 ohms and 160 watts per channel into 2 ohms. This was at the 8-ohm setting. For the 4-ohm setting, the equivalent figures were 190 watts, 290 watts and 160 watts.

These figures largely confirm NAD's claim of +6dB for headroom and mean that the effective power on program material is dramatically larger than indicated by the fairly modest figures for continuous power output.

As far as the soft clipping feature was concerned though, we were not convinced. Granted, the visual effect on the oscilloscope is to give a gently rounded waveform at the onset of clipping.

But the measured distortion is a great deal higher. For example, if the amplifier is set to clipping for a distortion reading of 1% and then the soft clipping circuitry is switched in, the distortion increases to 4.5%. Nor can it be regarded as less audible although the nature of the perceived distortion does change slightly. If your ears have a rolloff above 10kHz, you might regard the distortion with soft clipping switched in as being worse. In our opinion then, the soft clipping circuitry could be omitted and the user would be best advised to leave it switched out.

Signal-to-noise ratio for the CD and line level inputs was 90dB unweighted with respect to 40 watts into 8-ohms. Separation between channels was 74dB at 100Hz, 68dB at 1kHz and 50dB at 10kHz. Other specs checked out pretty much in line with NAD's claims.

Our conclusions, after listening to the NAD 3240PE, is that it is a very good sounding amplifier with a very big reserve of power output but that the soft clipping feature could have been omitted. It is sure to be a big seller.

Recommended retail price of the amplifier is $599.00. Further information can be obtained from high fidelity retailers or from the Australian distributors for NAD equipment, The Falk Electrosound Group, 28 King St, Rockdale, NSW 2216. (L.D.S.)

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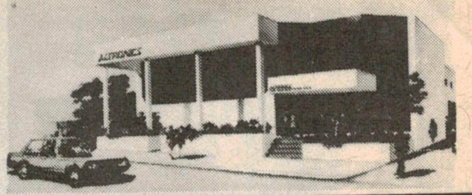

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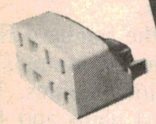

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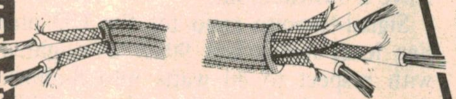

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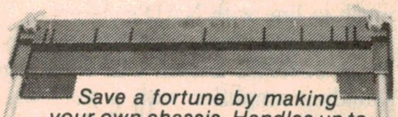

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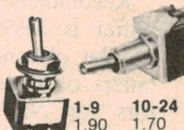

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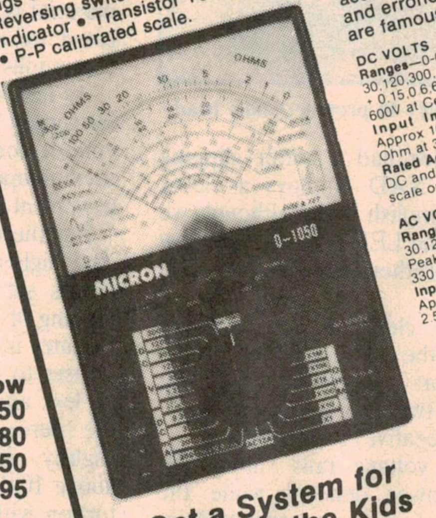

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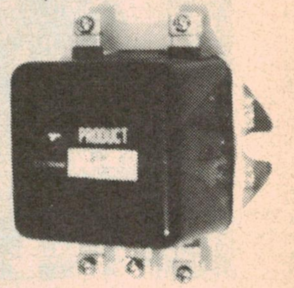

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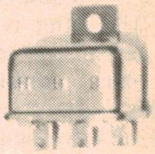

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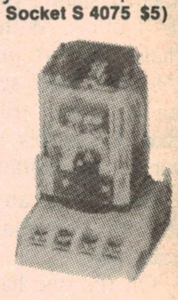

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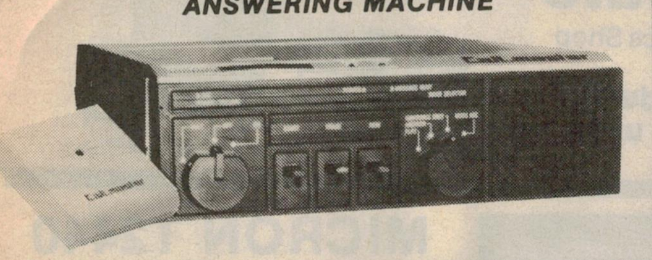

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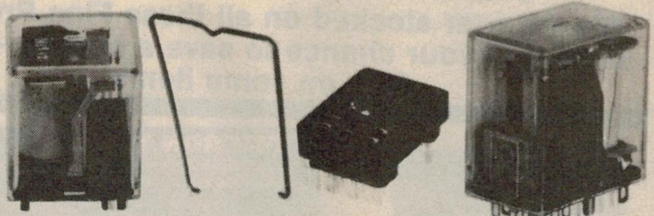

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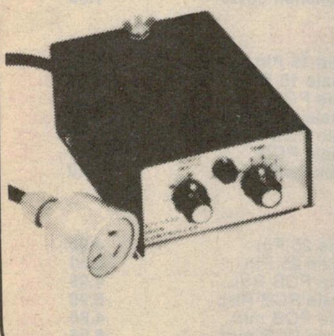

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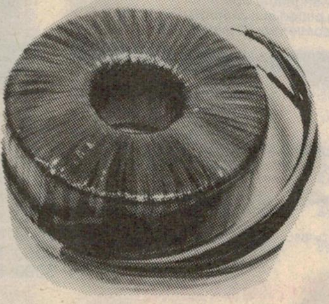

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SEC 1	45V 1.8A	SEC 1	45V 3.3A
SEC 2	45V 1.8A	SEC 2	45V 3.3A
WERE	~~$55~~	**WERE**	~~$69.95~~
NOW	**$38 ea**	**NOW**	**$48 ea**

W/PROOF PA SPEAKERS

PVC 5 WATT 8 OHM

C 2010 . . . ~~$11.75~~

NOW $8.50 ea

PVC 10 WATT 8 OHM

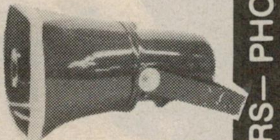
C 2015 . . . ~~$13.50~~

NOW $9.50

ALUMINIUM 15 WATT 8 OHM

C 2025 . ~~$29.95~~

NOW $25



ALUMINIUM 15 AND 30 WATT FITTED WITH LINE TRANSFORMER

15W Taps 660/15W, 1K/10W, 2K/5W 4K/2.5W

C 2030 . . . ~~$79.95~~

NOW $65

30W Taps 330/30W, 660/15W, 1K/10W, 2K/5W 4K/2.5W.

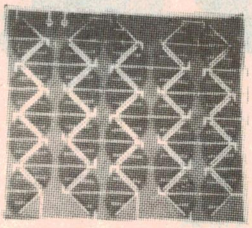
C 2033 . . ~~$99.95~~

NOW $80

Warehouse Moving Sale

Yes we've now moved to our Fantastic New Electronics Shop and Warehouse at 174 Roe Street, Perth.

We are over stocked on all these Fine Products so here is your chance to save a bundle — up to 50% on some items

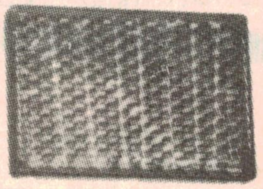


Price Break Through Solar Cell Array 18V @ 7 Watt

Brilliant New Solar Array at an amazing price. Yes, for less than $90 we now have just the handiest Solar Modules available (Why pay our competitors $239 for a measly 3 additional watts?? Superb for Powering or Charging 12 - 15 Volt circuits - Now there's now excuse for that flat Car, Boat or Caravan Battery. Solar Cells are fixed to a fibre board, front covered with tough EPS and rivetted into stainless steel frame. **Cat No. A 0220**

Amazing Price Break Through

$89.95

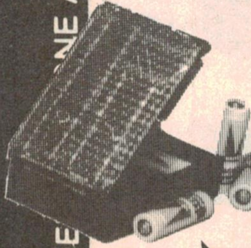


Solar Cell Module .4V at 450mA

Great experimenters Solar Module. Connect in parallel or series as you wish. Terminal strap enables easy interconnection to other cells. **A 0210**

Value $4.50

10 cells or more $3.98ea



SOLAR CHARGER

For 4AA Nicads

A 0230

~~$12.~~ **$10**

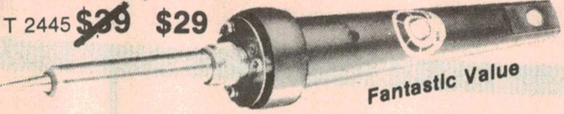
Save a Bundle on these Fantastic Micron Soldering Irons

Temperature Adjustable 250° C to 450° C

Excellent new iron, screwdriver temperature adjustable between 250° C and 450° C enabling very delicate soldering on low settings with surprising heat energy reserve on maximum setting.

Relative temperature is indicated by LED lamp brightness. Much lower cost than a soldering station. **T 2445**

T 2445 ~~$39~~ **$29**



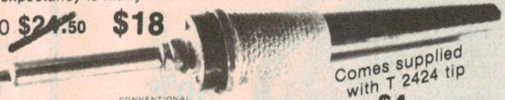
Fantastic Value

Professional Temperature Fixed Soldering Iron

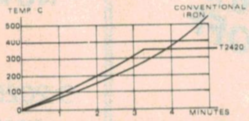
- 370 deg. Fixed Temperature • High efficiency patented heating element.
- Iron clad, chrome plated, long life interchangeable tips.

This iron uses high grade iron clad, chrome plated and pretinned tips. Tip life expectancy is many times that of conventional plated tips.

T 2420 ~~$24.50~~ **$18**



Comes supplied with T 2424 tip



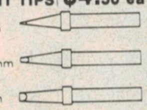
HEAT UP AND RECOVERY

REPLACEMENT TIPS $4.50 ea

MICRO CHISEL T2423 1mm

MINI CHISEL T2424 1.5mm

STD CHISEL T2425 3mm



Professional Megaphone PA

A 1990

~~$109.50~~ **$99**

SPECIFICATIONS:

Power Output	20 Watts max.
Effective Range	Approx. 400M (up to 1KM in ideal conditions)
Power	8 Pcs Cell (not Included)
Dimensions	230 Diam. 360 Length
Weight	1.5K (less batteries)
Shoulder Strap	Supplied

Refer to Our 1987 Catalogue for full Specifications on These Fine Quality Products

MICRON T2440

Electronic Temperature Controlled Temperature Selectable Soldering Station

The MICRON T 2440 soldering station, offers the ultimate in controlled temperature hand soldering. 320°C, 350°C, 380°C, 410°C (608°F, 662°F, 716°F, 770°F and 824°F) fixed temperatures are selectable by rotating the detained rotary switch freely without changing heater or tip.

Heat Capacity Full 48 Watts • Temperature Control +or - 3 deg.C • Zero Voltage Switching • Grounded Tip • Low Voltage Element 24V • Chrome Plated Tip. T 2440

Normally ~~$119.95~~

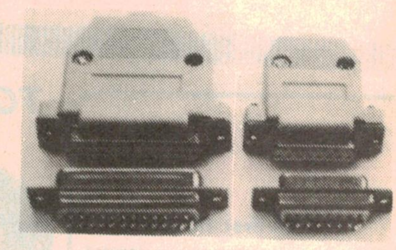
This Month **$99.00**

******

Save Up To 50% On Top Quality D Series Connectors!

Fantastic Value

D Series Computer Connectors. Gold Plated Professional series



DB9

		WERE	NOW
P 3000	Male 9 Pin	2.95	1.70
P 3010	Female 9 Pin	3.25	2.35
P 3020	Male PCB Rt/L	3.75	1.85•
P 3030	Fmale PCB Rt/L	4.50	2.20•
P 3040	Male PCB mnt.	2.95	1.95
P 3050	Fmale PCB mnt.	3.95	2.25
P 3090	Backshell cover	1.95	.95

DB15

		WERE	NOW
P 3100	Male 15 Pin	3.25	2.25
P 3110	Fmale 15 Pin	3.85	2.60
P 3120	Male PCB Rt/L	4.35	2.10•
P 3130	Fmale PCB Rt/L	5.50	2.95
P 3140	Male PCB mnt.	3.85	1.90
P 3150	Fmale PCB	4.85	2.40•
P 3190	Backshell cover	2.20	1.00

DB25

		WERE	NOW
P 3200	Male 25 Pin	4.95	2.47•
P 3210	Fmale 25 Pin	5.50	2.74•
P 3220	Male PCB Rt/L	4.95	3.50
P 3230	Fmale PCB Rt/L	6.90	4.95
P 3240	Male PCB mnt.	4.95	4.95
P 3250	Fmale PCB mnt.	6.25	4.95
P 3290	Backshell cover	2.20	1.10•

See Review Electronics Australia March '86

BRILLIANT AUTO RANGING DIGITAL MULTIMETER

$99.95

Autoranging with Memory Function for Relative Measurements

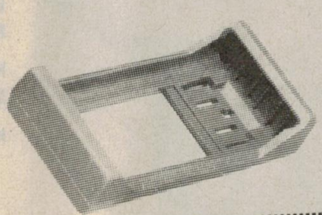
SPECIFICATIONS:

DC VOLTAGE	
Ranges	5 (200mV, 2V, 20V, 200V, 1000V)
DCV Accuracy	0.5% + 1DGT
AC VOLTAGE	
Ranges	4 (2V, 20V,200V,750V)
ACV Accuracy	0.75%+5 DGTS
Input Impedance	10M Ohm Min.
DC CURRENT	
Accuracy	20mA—0.75%+1DGT 10A-1.50%+5DGTS

Free Select either a Carry Case or Holster this month with your Q 1075 at no charge

Carry Case
Keep your **Labtech** DMM looking like new for years!
Q 1076 **$9.50**

Holster Q 1077 **$9.50**
What's this? For want of a better name we've named this thick rubber "Cliparound" protector a "Holster" Great protector for field use, dropping on concrete floors etc. —



Now Only ~~$99.00~~ **$75**

UV EPROM ERASER

Erase your EPROMS quickly and safely. This unit is the cost -effective solution to your problems It will erase up to 9 x 24 pin devices in complete safety in about 40 minutes for 9 chips (less for less chips). • **Erase up to 9 chips at a time** • Chip drawer has conductive foam pad • Mains Powered • High UV intensity at chip surface ensures thorough erase • Engineered to prevent UV exposure • Long Life UV tube • Dimensions 217 x 80 x 68mm • Weight 670 grams

LOGIC PROBE

Q 1272

New 20MHz Model. **$20** ~~$34.95~~

Max. Input Frequency 20MHz. Input Impedance 1M ohm. Operating supply Range 4 volt minimum. TTL Logic 1 Hi LED greater than 2.3 volts. Logic 0 Lo LED less than 0.8 volts. CMOS Logic 1 Hi LED greater than 70% Vcc. Logic 0 Lo LED less than 30% Vcc. Minimum Detectable pulse width 30 nano seconds. Maximum signal input 220V AC/DC (for 15 secs.)

Check Appliances And Electrical Wiring

Build This 1000V Megohm Meter
(1985 Successor to the "Megger")

It uses a transistor inverter to produce a regulated 1000V DC supply which is applied to the insulation under test. Insulation resistances between 2M Ohm and more than 2000 Ohm can be measured.
K 2550 (See EA July '85)

JUST $55

Don't Miss Out! Reserve Your Order Right Now — Phone STD Free On 088 999 007

The reproductive purity of these speakers simply amazed us. The secret, of course is the DANISH VIFA Drivers. VIFA drivers are used in many top selling imported systems such as Bang & Olufsen, Rogers, Mission, Jamo, DCM Timewindow etc.

Build These Fantastic New Playmaster HiFi Loudspeakers

See Electronics Australia Sept '86

$449 full kit K 5090

If your budget won't run to the $600 to $800 needed for a fully imported pair of equivalent speakers, these are the ones to go for.

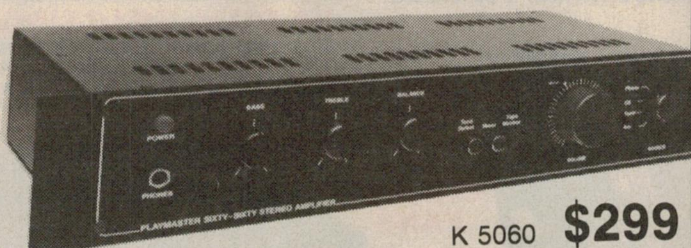
'Sixty-Sixty' Integrated Amplifier Kit

(EA May,June,July '86)

Features:
• 60 watts per channel into 8 ohm loads • Very low noise on all inputs - better than CD performance • Very low distortion • Excellent headroom • Tape monitor loop • Tone controls with centre detent and defeat switch • Mono/stereo switch • Toroidal power transformer • Easy-to-build construction • Very little wiring.

Performance Specification

Power Output — 8 ohms 62W **Distortion** - Less than .0% at 1kHz. **Frequency Response** - Phono Inputs - RIAA/IEC equalisation within + - 0.5db from 40Hz to 20kHz Line Level Inputs — -0.5db at 20Hz and -1db at 20kHz **Input Sensitivity** - Phono 1kHz -4.3mV • Line Level Inputs - 270mV. **Hum & Noise** - Phono - 89db • High Level Inputs - 103db. **Tone Control - Bass** - + -12db at 50Hz **Treble** - +-12db at 10kHz. **Damping factor** - At 1kHz and 30Hz - greater than 80 **Stability** — Unconditional.



K 5060 **$299**

"This New Amplifier offers a standard of performance far ahead of anything we have previously published and ahead of most commercial integrated Stereo Amplifiers".
"It is half to one third of the cost of an imported Amplifier with equivalent power output and performance", *Says Leo Simpson Managing Editor Electronics Australia Magazine.*

Beginner constructors can Build this Amplifier Kit — It looks terrific and will last you a lifetime.

Save $200 or more on comparable performance commercial units

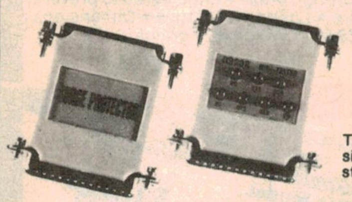
PHONE YOUR ORDER — ALTRONICS TOLL FREE 008·999·007

Warehouse Moving Sale

Yes we've now moved to our Fantastic New Electronics Shop and Warehouse at 174 Roe Street, Perth.

We are over stocked on all these Fine Products so here is your chance to save a bundle — up to 50% on some items

BUILD THESE FANTASTIC KITS



QUALITY IMPORTED RS-232 ACCESSORIES

Surge Protector

D 1510 **$19.50**

The RS-232 Surge Protector is used to protect RS-232 ports from the possibility of costly damage from large voltage peaks caused by lightning or other power problems. The surge protector used Metal-Oxide Varistors (MOV) to protect pins 2,3 and 7. The MOV's will suppress any voltage above 26 volts without affecting the normal RS-232 voltage levels.

Jumper Box

D 1520 **$9.95**

The RS-232 Jumper Box is used to make custom RS-232 interfaces. It consists of a small board with a connector on each end.

Mini Tester

D 1500 **$19.50**

This Tester indicates the presence of all important interface lines by LED illumination when signal is active.

Null Modem

D 1530 **$9.95**

The RS-232 Null Modem is used to replace a set 25-pin RS-232 connectors with transit DATA and receive DATA CROSS CONNECTED (Pin 2 of each connector goes to pin 3 of the other connector). Pins 1 and 7 are connected straight through. Each connector is set up in the loop back mode with pins 4 and 5 shorted together and pins 6,8 and 20 shorted together. The RS-232 Null Modem is used when the proper operation of a set of modems is in doubt. It also is handy when Transmit DATA and Receive DATA need to be reversed.

FANTASTIC HI TECH - HI SPEC
Audio Oscillator and Function Generator

This Ultra low distortion oscillator is comparable with the very best laboratory standard sine wave oscillators. As well as having very low distortion it has excellent envelope stability, square wave output and output metering

2 Models to choose from (metered and unmetered)

• Frequency range 10Hz - 100KHz in 4 ranges • Output level 3V RMS max adjustable • Attenuator Odb, -10db, -20db, -30db, -40db, -50db plus fine adjustment • Output impedance — 600 ohms unbalanced • Output waveforms — sine and square.

All components mount on one single PCB.making it a breeze to Construct

Save $200 and More by Building this Fine Kit Project

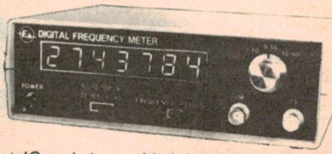
K 2540 Complete Kit with Front Panel Metering **$155**

K 2545 Complete Kit Without Metering **$139**

7 Digit Frequency Counter

Unbelievable 0.005% Accuracy

★ frequency and Period measurement to 500 MHz (with optional prescaler) ★ High input sensitivity. Professional unit at a fraction of the cost of built up units.



★ IC sockets provided throughout ★ Low age rate 10,000 MHz XTAL ★ Quality ABS plastic case with deluxe front panel ★ Specified LS1.

K 2500 **PRESCALER** **$149.50**

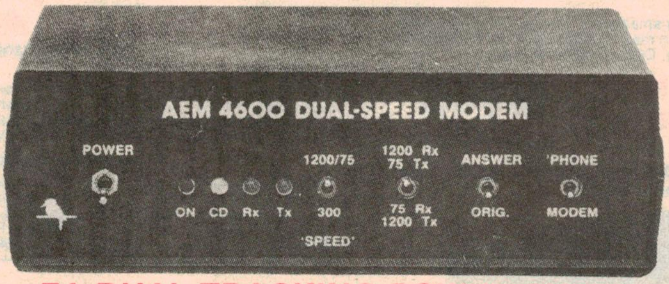
K 2501 **DECIMAL POINT** **$42.00**

K 2502 **$12.50**

A 'Dual-Speed' Direct-Connect Computer Modem

Features: The project supports 300 Baud full duplex operation and 1200/75 Baud half duplex operation. That is, you can transmit and receive at 300 Baud in both directions or 1200 Baud one way, 75 Baud the other. A switch has been incorporated allowing you select either 1200 baud.

K 9600 **A Fantastic Performing Modem Only $169**



Bench Top Power Supply

3-30V to 1 amp Max.with variable current limit

$79.00

FEATURES:
★ Output 3 to 30V at 1A ★ Short circuit protected ★ Load switching ★ Current limiting. Dual scale meter ★ Housed in our Deluxe "ABS" instrument case.

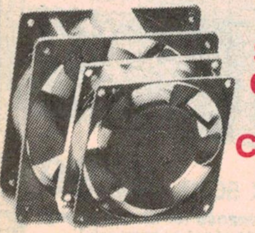
SPECIFICATIONS:
★ Output Voltage - 3 to 30V ★ Output Current - 0 to 1 amp (fully variable) ★ Load Regulation - Better than 0.2% from 0 to full load ★ Output Ripple-Less than 2mV RMS. Cat. **K 3210**

EA DUAL TRACKING POWER SUPPLY

The Ideal Power Supply For The Audiophile Experimenting With Linear Op Amp Designs

• Floating Ground • Meter Switchable V to A • Voltage adjustable to within 10mV
• Output + or - 1.3V to + or - 22V at 2 Amps + 5V @ 1.0 Amps. **K 3320**

$129.95



SILKY QUIET 240V COMPT. FANS

F 1020 80mm Diam. **$24.50**

4 or More **$21.00**

TEMP.CONTROLLED SOLDERING STATION

(EA Sept.'86)

Controls the temperature of your standard soldering iron. Suitable for irons rated from 20W—75W - Standard soldering iron plugs straight in, no need for modification. The Altronics Kit comes complete — pre-punched and silk screened.

K 6400 **$35.00**

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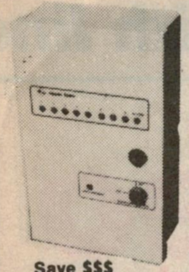

Super Low Price on Famous EA 8 Sector Alarm System Kit

(See EA Mag.Jan '85)

Fantastic Value

FEATURES:

Alarm has 8 separate input circuits - 8 sectors can be monitored independently. Each input circuit is provided with an indicator LED and a sector On/Off switch. Individual sector isolation. Inputs accept both normally closed and normally open sensors. Two Inputs provided with an entry delay (between 10-75 sec.) Internal trip warning buzzer - alerts owner/ocupant of pending alarm operation - great for the "forgetful" amoungst us. This buzzer is pre-settable between 5 and 55 seconds prior to Alarm. Unique circuit detects automatically when any N/O or N/C loops are either open circuit or dead short. **e.g. someone trying to bridge reed switches etc.** Switched output can be used to send a silent alarm through an auto-dialler circuit or similar. Full battery back up via. 12V - 1.2Ah battery. Supplied in an attractive functional security case.

Save $$$ on the cost of commercial equivalents

Within the Capacity of the beginner constructor

K 1900 (without Backup Battery) **$139.50**

S 5065 12V 1.2AH Backup Battery **$22.95**

Digital Capacitance Meter Checks capacitor value from 1pF to 99.99uf over three ranges. Features include a nulling circuit and bright 4-digit LED display. (See EA Aug. '85)

Low-Cost Unit Checks Values from 1pF to 100uF

Upgraded Digital Capacitance Meter

K 2522 **$79**

240V Mains Power From Your 12V Battery

300 Watt Inverter with Auto Start

(See EA Sept.'85)

Just think how handy is would be to have 240 Volt AC Mains Power when camping or for your boat or Caraven. **Auto Start** draws power from your battery only when appliance is plugged in and "turned on" i.e. battery can be left permanently connected if desired. **Thermal Over Load. Current Regulated. Current Overload.**

K 6752 Complete Kit **$229.00** K 6754 Fully built & tested **$329**

ALTRONICS

174 ROE STREET,PERTH

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$3.00 DELIVERY AUSTRALIA WIDE - We process your order the day received and despatch via. Australia Post. Allow approx.7 days from day you post order to when you receive goods. Weight limited 1Kgs.

$6.00 OVERNIGHT JETSERVICE - We process your order the day received and despatch via. **Overnight Jetservice Courier** for delivery next day Country areas please allow additional 24-48 hours. Weight limit 3Kgs.

$6.00 HEAVY SERVICE- For deliveries exceeding 3kgs and less than 10kgs-allow 7 days for delivery

$10.00 HEAVY HEAVY SERVICE- All orders of 10Kgs. or more must travel Express Road - Please allow 7 days for delivery.

INSURANCE — As with virtually every other Australian supplier, we send goods at consignees risk. Should you require comprehensive insurance cover against loss or damage please add 1% to order value (minimum charge $1).When phone ordering please request "Insurance".

TOLL FREE PHONE ORDER — Bankcard Holders can phone order toll free up to 6pm Eastern Standard Time. Remember with our **Overnight Jetservice** we deliver next day.

Altronics Resellers

Chances are there is an Altronics Reseller right near you - check this list or phone us for details of the nearest dealer.
Blue Ribbon Dealers are highlighted with a ■.These Dealers, generally carry a comprehensive range of Altronic products and kits or will order any required item for you.
Don't forget our Express Mail and Phone Order Service - for the cost of a local call, Bankcard, Visa or Mastercard holders can phone order for same day despatch.
Please Note: Resellers have to pay the cost of freight and insurance and therefore the prices charged by individual Dealers may vary slightly from this Catalogue - in many cases, however, Dealer prices will still represent a significant cost saving from prices charged by Altronics Competitors.

MORE ALTRONICS DEALERS WANTED

If you have a Retail Shop, you could increase your income significantly by becoming an Altronics Dealer. Phone Steve Wroblewski (09) 328 2199 for Details.

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Solex ■ 722015

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Simple unit mixes two mic inputs with line

Low-cost stereo mini mixer

Here's a low-cost stereo mixer that should be just right for many applications. It hooks into the tape loop of a conventional stereo amplifier and can be used to mix two microphones with line level signals from an amplifier, musical instruments, or a tape recorder.

by BRANCO JUSTIC

Most stereo mixers are rather large and elaborate affairs but not this one. It goes with your existing hifi amplifier and will let you mix two microphone inputs with program material derived from a hifi tuner, turntable, CD player or tape recorder. It's just the shot for small public address applications or for adding commentary to a slide show.

Because the mixer is installed in the tape loop of the amplifier, all the existing functions of your system are retained. In addition, you can independently adjust the program and microphone levels in any proportions you desire. The resultant stereo output is then fed to the amplifier tape input sockets and is also made available to the tape recorder input sockets.

Another possible application of the Mini Mixer is to use its line inputs as instrument inputs, eg, from a guitar or electronic keyboard. In this role, the optional mono output from the mixer can be fed to a mono amplifier, or to a stereo amplifier switched to mono mode. Result — a simple 4-input mixer with two instrument and two microphone inputs.

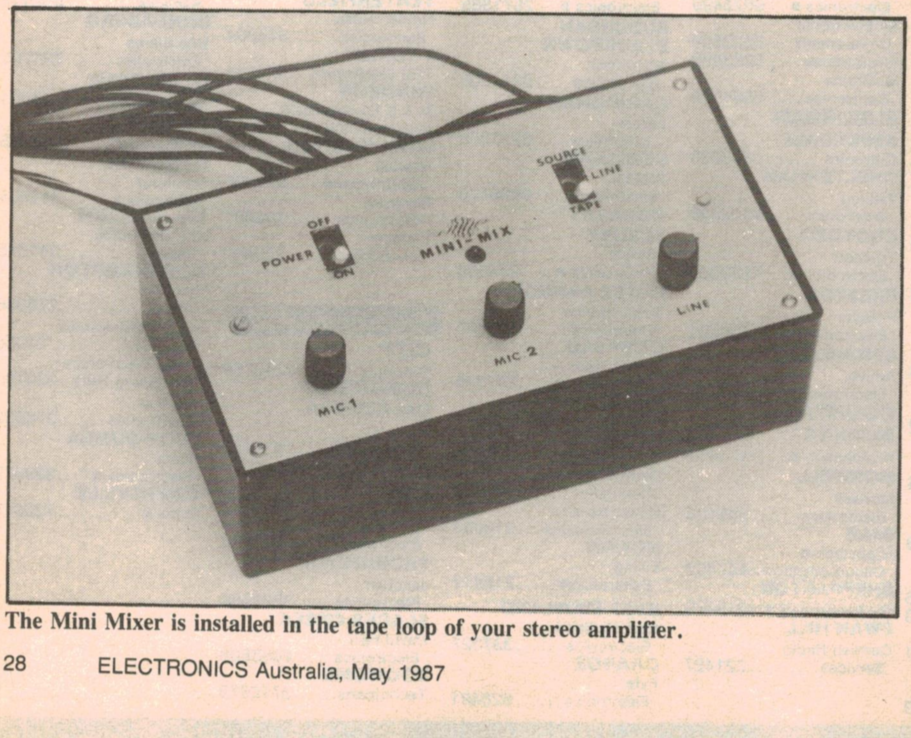
Let's now take a look at the controls on our new Mini Mixer. In the interests of simplicity and low cost, these have been kept to an absolute minimum. As can be seen in the photograph, there's a power on/off switch, a line/tape switch, and three potentiometer controls which set the signal levels from the microphones and the selected program.

The line/tape switch simply selects the program material to be mixed with the microphone inputs. In the line position, the signal is taken from the amplifier tape outputs; in the tape position, the signal comes from your tape recorder.

The only other item on the front panel is a power on/off indicator LED. The rear panel accommodates the two microphone jack sockets.

A problem that arises with most mixers is that, when the time comes to use them, you can never find the necessary interconnecting cables. This design solves that problem simply by using captive cables. The cables are soldered directly to the mixer's printed circuit board at one end and are fitted with RCA plugs at their free ends for connection to the amplifier and tape recorder.

So, wherever the mixer goes, the interconnecting cables go.



The Mini Mixer is installed in the tape loop of your stereo amplifier.

level signals

How it works

Refer now to Fig.1. The circuit is really very simple and is based on two TL071 op amps configured as summing amplifiers.

Double pole switch S1 selects either the amplifier tape outputs or the tape recorder outputs. The selected inputs, together with the microphone inputs (Mic 1 and Mic 2), are then fed to level potentiometers RV1-RV3. After that, the various signals are AC-coupled via C1-C4 to the two summing amplifier circuits.

Each summing amplifier circuit consists of a simple resistive mixer network followed by an inverting op amp stage. IC1 and its associated resistor network (R1-R3) sums the signal sources for the left channel while IC2 looks after the right channel. R7 and R8 set the gain of their respective op amp stages, while C5 and C6 ensure high frequency stability by rolling off the response above 70kHz.

Note that the left and right channel line input signals are fed only to their respective left and right channel summing amplifiers, while the microphone inputs are fed to both channels. A high degree of isolation between channels is maintained due to the virtual earth characteristic at the signal input of each op amp.

The outputs from the operational amplifiers are AC-coupled via C7 and C9 to the appropriate inputs on the amplifier and tape recorder. A simple resistive mixer consisting of R9, R10 and R15 provides an optional mono output whilst retaining a high degree of channel separation.

Power supply

The Mini Mixer can be powered by batteries or by a DC or AC plugpack supply. The acceptable range of voltage is 6-20V DC or 4-15V AC.

Diodes D1-D4 form a bridge rectifier which feeds into D5. The output of D5 is then filtered by C9 and fed via on/off switch S2 to a filter/voltage divider network (C10, C11 and R12-R14) which provides the bias for the non-inverting inputs of the op amps. Power indication is provided by LED D6 which is wired in series with current limiting resistor R11 across the supply rails.

Because a bridge rectifier is used, an external DC plugpack supply (if used) can be connected with either polarity.

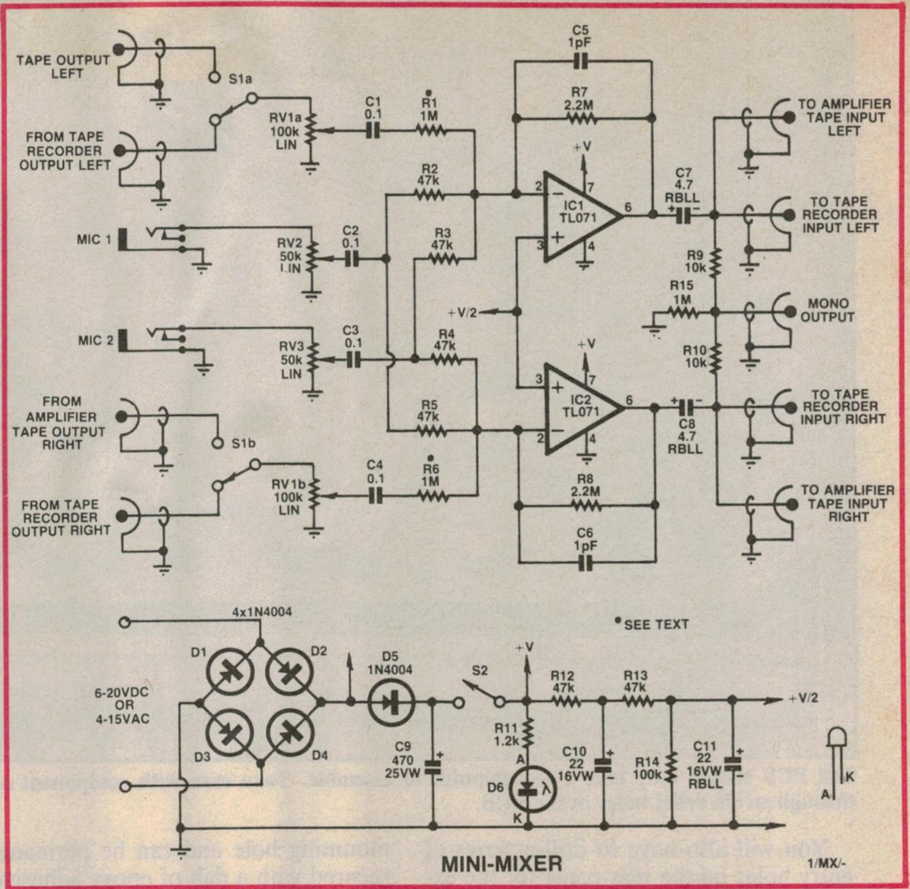


Fig.1 the circuit uses two op amp ICs configured as summing amplifiers.

D5 serves to isolate the filter circuitry so that an optional VU meter (to be described next month) can be powered from the output of the bridge.

Construction

A complete kit of parts for this project is available from Oatley Electronics (see price panel).

Virtually all the parts, including the potentiometers and switches, are mounted on a single printed circuit board (PCB) coded 87/mx/5. This is housed in a standard plastic case measuring 195 x 113 x 60mm.

Begin construction by filing rectangular openings in the PCB to clear the switch toggles (but not the plastic pivot assemblies). Once this has been done, the parts may be installed on the PCB as shown in Fig.2. No special procedure need be followed when installing the parts, but watch the orientation of the electrolytic capacitors, diodes and integrated circuits.

The switches, pots and electrolytic capacitors (C7-11) are all mounted on the copper side of the PCB. These parts are shown dotted on the layout diagram (Fig.2). Cut the pot shafts to a length of 15mm before installing the pots on the PCB.

Note that the switches are mounted on 5mm standoffs to provide clearance for the pivot assemblies. Short lengths of hookup wire are used to make the connections between the switch terminals and the PCB, and between the various pot terminals and the PCB.

The completed PCB can now be put aside and attention turned to the case. Two self-adhesive aluminium labels are supplied with the complete kit and these should be carefully affixed to the lid of the case and to the rear panel. This done, the case can be drilled and filed to accept the pot shafts and switch actuators, and to accept the two microphone sockets on the rear panel.

Specifications

Gain

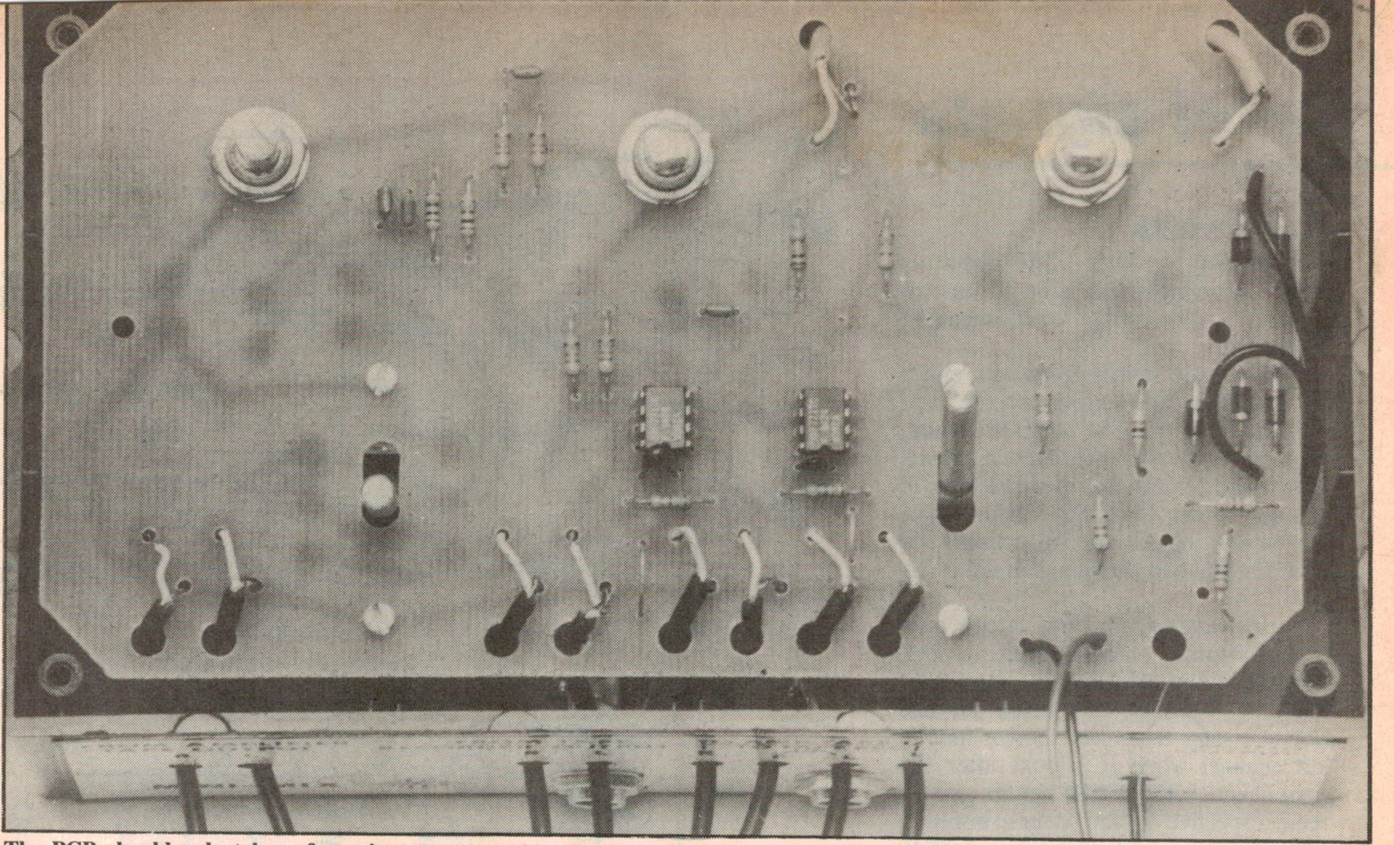
Line inputs	6.5dB (1kHz)
Mic. inputs	33.5dB (1kHz)

Signal-to-noise ratio

Line inputs	66dB (1V output)
Mic. inputs	62dB (1V output)

Frequency response

Line inputs	10Hz-20kHz (-3dB)
Mic. inputs	70Hz-20kHz (-3dB)



The PCB should only take a few minutes to assemble. Take care with component orientation and note that the external leads are run through strain relief holes in the PCB.

You will also have to drill a series of entry holes on the rear panel for the external connecting leads and for the power supply leads. These holes can all be 4mm in diameter.

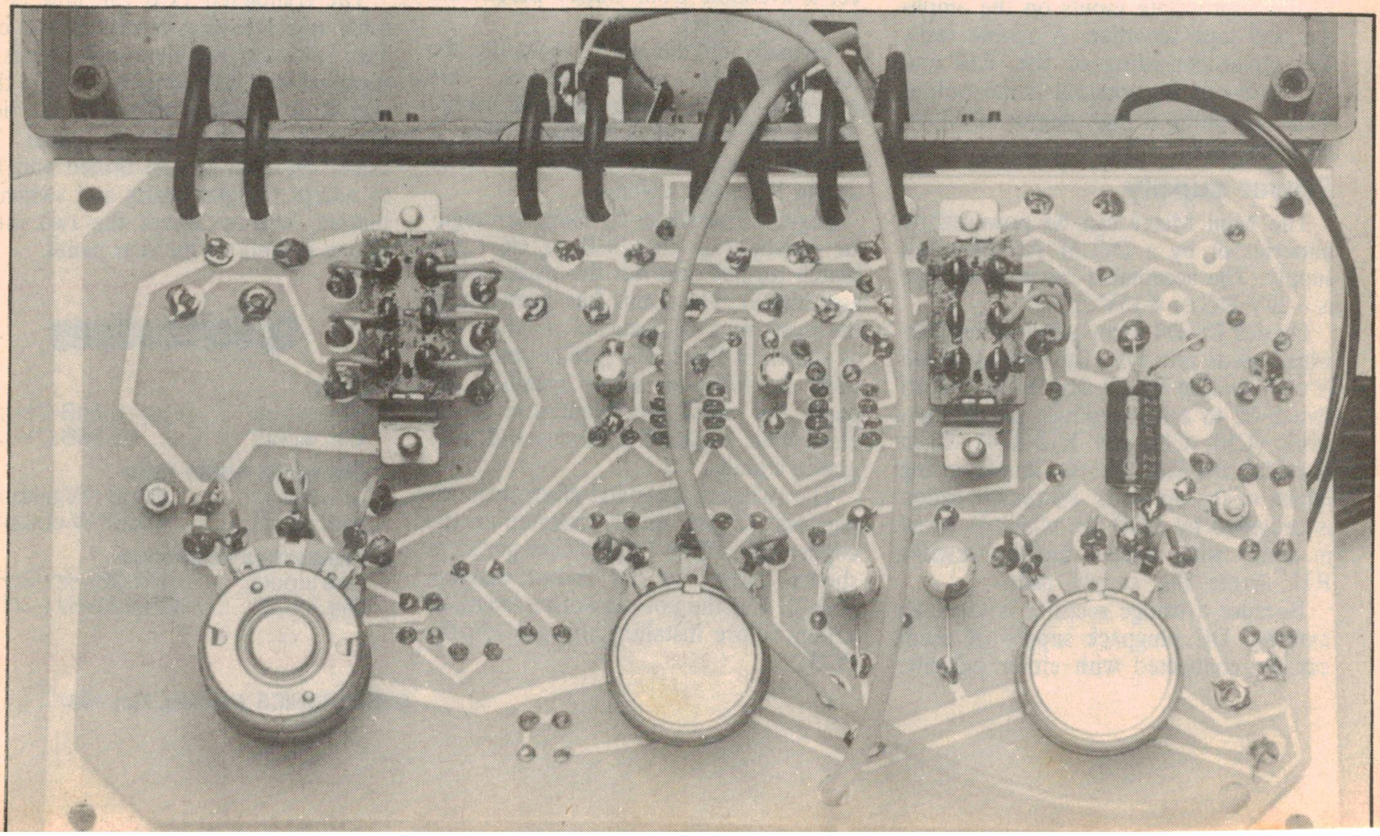
Finally, two 3mm mounting holes should be drilled in the front panel (to match the PCB mounting holes), along with a hole for the indicator LED. The latter should be a push fit into its mounting hole and can be permanently secured with a dab of epoxy adhesive.

All that remains now is the wiring and final assembly. The input, output and power leads are run to the PCB via the holes provided in the rear panel and via the strain relief holes on the PCB itself (see photo). The RCA sockets are wired using short (approx. 200mm) lengths of shielded audio cable while the LED is connected using ordinary hookup wire.

Be careful not to confuse the anode and cathode leads, otherwise the LED won't work.

Once the wiring has been completed, go over your work and carefully check for wiring errors. In particular, check that all polarised parts have been installed correctly. This done, the PCB

The pots, switches and electrolytic capacitors are all mounted on the copper side of the PCB.



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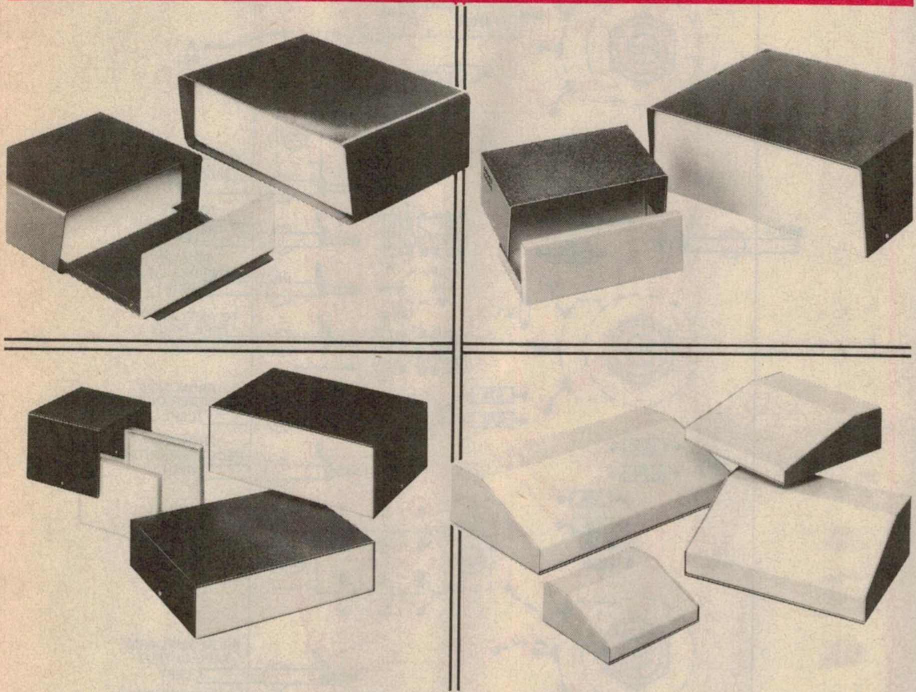

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can be mounted on the front panel on 5mm spacers and secured using machine screws and nuts.

Testing

It is a good idea to check the power supply voltages before connecting the unit to your amplifier. To do this, switch on and check that the supply voltage across C9 is between 6V and 20V DC. If this is correct, check that the voltage on pin 3 of each IC is at half supply.

It's now simply a matter of hooking the unit up to your amplifier, plugging in a microphone, and testing to see that everything works correctly. You should be able to vary the relative levels of the different signal sources using the front panel controls.

Finally, note that R1 and R6 may be reduced to increase the line input sensitivity. This may be necessary in order to use the line inputs as instrument inputs.

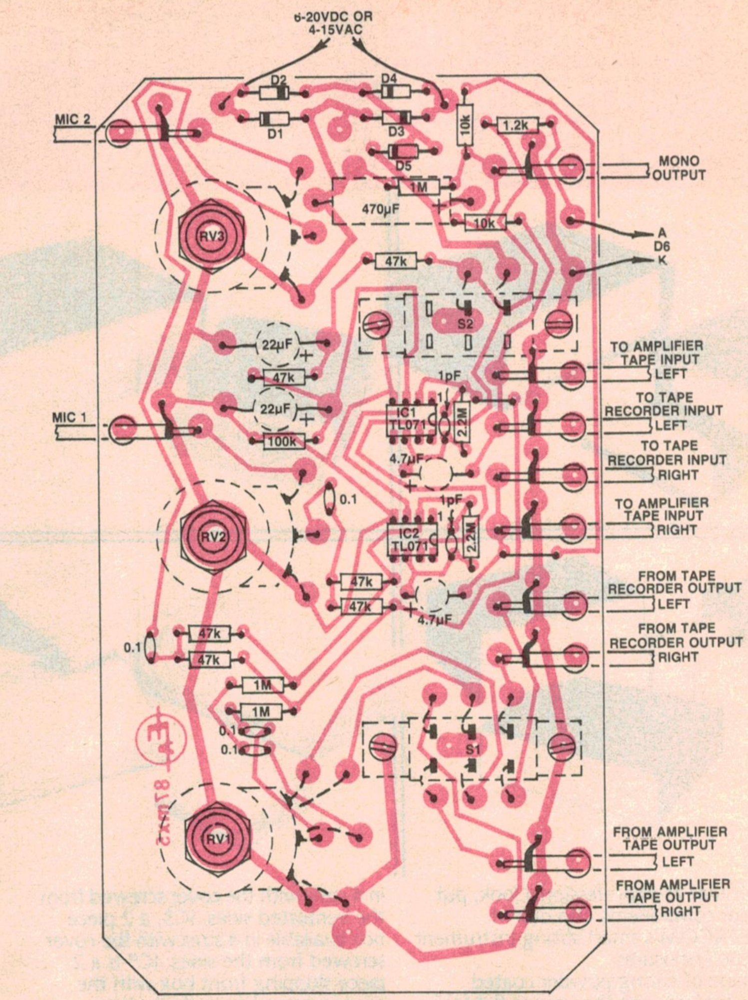


Fig.2: the parts shown dotted are all mounted on the copper side of the PCB.

Where to buy parts: parts for this project are available from Oatley Electronics, 5 Lansdowne Pde (PO Box 89), Oatley, NSW 2223. Phone (02) 579 4985. Note: copyright for the PC artwork for this project is owned by Oatley Electronics.

Prices are as follows:

PCB plus on-board components	**$27.95**
Complete kit of parts (excluding plugpack)	**$48.95**
12V AC plugpack	**$11.50**

PARTS LIST

1 PCB, code 87mx5, 182 x 10mm
2 DPDT toggle switches
1 plastic case, 195 x 113 x 60mm
1 self-adhesive label for front panel
1 self adhesive label for rear panel
4 RCA/RCA shielded audio leads (cut in half)
2 6.5mm microphone sockets
1 plugpack power supply (see text)
6 5mm standoffs

Semiconductors

5 1N4004 silicon diodes
2 TL071 JFET input op-amps
1 5mm red LED

Capacitors

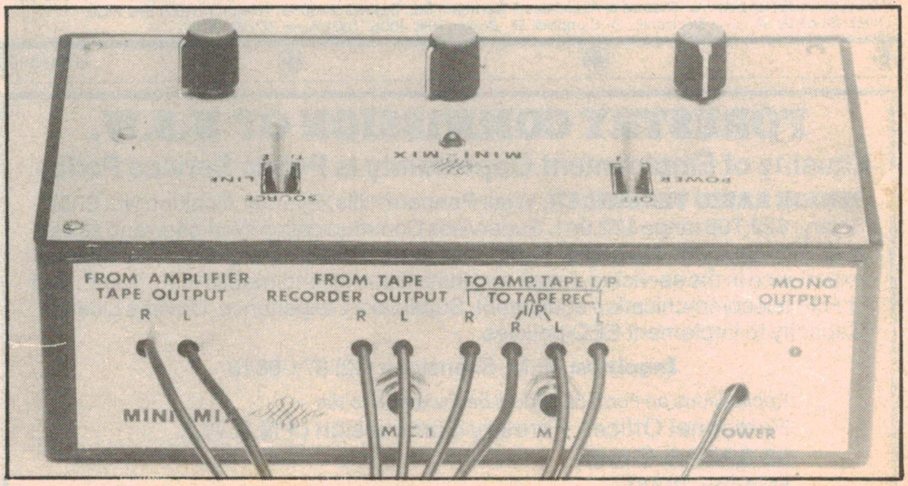
1 470µF 25VW electrolytic
2 22µF 16VW low leakage electrolytic
2 4.7µF 16VW low leakage electrolytic
4 0.1µF monolithic
2 1pF disc ceramic

Resistors (0.25W, 5%)

2 x 2.2MΩ, 3 x 1MΩ, 1 x 100kΩ, 6 x 47kΩ, 2 x 10kΩ, 1 x 1.2kΩ, 1 x 100kΩ linear dual gang potentiometer, 2 x 50kΩ linear single gang potentiometers

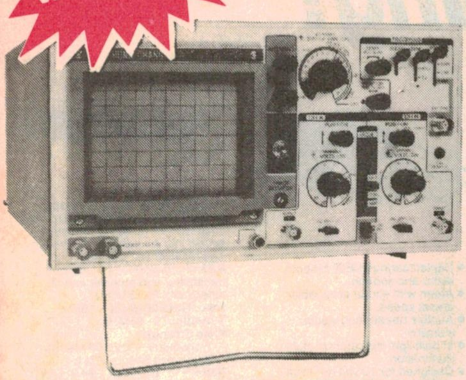
Miscellaneous

Hookup wire, machine screws and nuts, shielded audio cable.



The two microphone jack sockets are mounted on the rear panel.

12 months warranty!



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Acceleration potential: 2KV

VERTICAL
Operating Modes: CH-A, CH-B, DUAL, ADD (CH-B can be inverted.)
Dual modes: Alter; 0.2ufs - 0.5ms/div. Chop; 1ms - 0.5s/div.
CHOP frequency 200KHz approximately.
Deflection factor: 5mV/div 20V/div +/−3%, 12 ranges in 1-2-5 step with fine control.
Bandwidth: DC; DC - 20MHz (−3dB). AC; 10Hz - 20MHz −3dB).
Rise Time: Less than 17ns.
Overshoot: Less than 3%.
Input Impedance: 1M ohm +/−5%, 20pF +/−3pF
Maximum Input Voltage: 600Vp-p or 300V (DC+AC Peak).
Channel Isolation: Better than 60 dB at 1KHz.

HORIZONTAL
Sweep Modes: NORMAL, and AUTO
Time Base: 0.2ufs - 0.5s/div +/−3%. 20 ranges in 1-2-5 step with fine control.
Sweep Magnifier: 5 times (5X MAG).
Linearity: 3%.

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Sensitivity: INTERNAL: 1 div or better for 20Hz - 20MHz (Triggerable to more than 30MHz). EXTERNAL: 1Vp-p or better for DC - 20MHz (Triggerable to more than 30MHz).
Source: INT, CH-A, CH-B, LINE and EXT.
Slope: Positive and Negative, continuosly variable with level control PULL AUTO for free-run.
Coupling: AC, HF-REJ and TV. TV SYNC Vertical and Horizontal Sync Separator Circuitry allows any portion of complex TV video waveform to be synchronized and expanded for viewing TV-H (Line) and TV-V (Frame) are switched automatically by SWEEP TIME/DIV switch.
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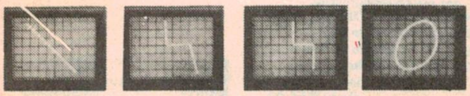

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Features...
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- Automatic polarity indication on DC ranges.
- All ranges fully protected plus Automatic "ZERO" of all ranges without short circuit except 200 ohm Range which shows "000 or 001".
- High Surge Voltage protection 1.5 KV-3 KV.
- Diode testing with 1 mA fixed current.
- Audible Continuity Test.
- Transistor hFE Test.

SPECIFICATIONS
Maximum Display: 1999 counts 3½ digit type with automatic polarity indication.
Indication Method: LCD display.
Measuring Method: Dual-slope in A-D converter system.
Over-range Indication: "1" Figure only in the display.
Temperature Ranges: Operating 0°C to +40°C
Power Supply: one 9 volt battery (006P or FC-1 type of equivalent)

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Features...
- Push-button ON/OFF power switch.
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- ½" high contrast LCD.
- Automatic over-range indication with the "1" displayed.
- Automatic polarity indication on DC ranges.
- All ranges fully protected plus Automatic "ZERO" of all ranges without short circuit except 200 ohm Range which shows "000 or 001".
- High Surge Voltage protection 1.5 KV-3 KV.
- Capacitance measurements to 1pF
- Diode testing with 1 mA fixed current.
- Audible Continuity Test.
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SPECIFICATIONS
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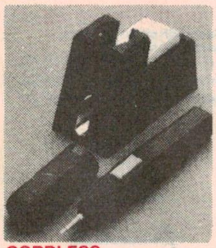

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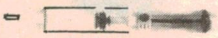

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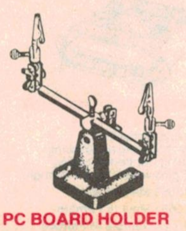

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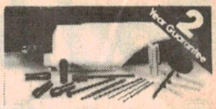

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A versatile 12V electric tool for...
- Sanding
- Engraving
- Grinding
- Polishing
- Cutting
- Drilling
- Milling
- Erasing, etc.

Features:
Operates on safe, low 12 volts from mains electricity via AC adaptor (supplied). Light and easy to handle with touch switch and lock for continuous running. High torque motor. 10,000 R.P.M. Can drill 2mm holes in steel. 2 year guarantee

Contents:
- 12V Super Tool
- Plugpack AC adaptor
- 1 spherical milling cutter
- 1 wire brush
- 1 grinding wheel
- 4 drill bits, 0.6, 0.8, 1.0, 1.2mm
- Set of 5 chuck collets
- 6 eraser sticks
- Instruction sheets

Cat. T12300 .... **$59.95**

POWERFULL MINI DRILL

Featuring a powerful 6000 r.p.m. motor, this lightweight (113gm) drill is ideal for many jobs. Perfect for PCB work! Has a 0.8 to 1.2mm chuck and 1mm drill bit. Requires 12V 1 AMP.(use with M19010)

Cat. T12302 .... **$17.95**

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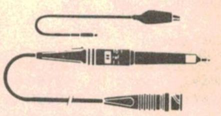
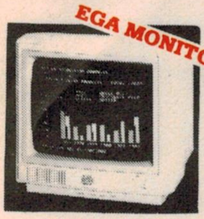


BESWICK 88100 PROBE SET

CONTAINS: Compensated probe lead with...
- Detachable 6 inch earth lead
- Retractable hook
- IC test tip
- Tip insulator
- BNC adaptor
- Trimming tool

SPECIFICATIONS:
Bandwidth: 10:1 position :250MHz at −3dB into 20 pF
Rise Time: 10:1 position less than 1.4ns nominal
Switch Function:
(a) 10:1 attenuation +/− 1%, with oscilloscope of 1 Mohm input resistance.
(b) 1:1 attenuation with bandwidth of 10 MHz approx.
(c) Reference position, tip grounded via 9 Mohm, oscilloscope input grounded.
Input Capacitance: 16pF typical depending upon oscilloscope input capacitance.
Compensation Range: oscilloscopes of 15 to 60 pF input capacitance.
Working Voltage: 600V DC or peak AC

$34.95



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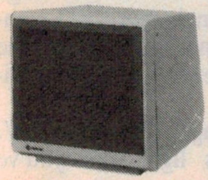
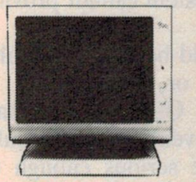
INTRA 14" RGB HIGH RESOLUTION COLOUR MONITOR
Compatible with IBM* and compatibles, and EGA Cards.
Why pay more?
Resolution: 640 x 350 dots
Dot pitch: .31mm
Display Format: 80 x 25 characters
Cat. X14514 ...... Normally $1,295
Our price $995

INTRA 14" RGB COLOUR MONITOR
Resolution: 640 x 200 dots
Display Format: 80 x 25 characters
Display Colours: 16
Dot pitch: .39mm
Sync Horiz. Scan Freq: 15.75 KHz
Sync Vert. Scan Freq: 50Hz
Band Width: 18MHz
Cat. X14520 .... **$695**

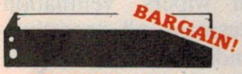


SAMSUNG TTL MONITOR
A quality 12" TTL monitor, with a high contrast, non-glare screen at a very reasonable price!
SPECIFICATIONS:
CRT: 12" diagonal 90° deflection, non-glare screen.
Active Display Area: 216(H) x 160(V)mm
Display Characters: 2,000 (80 characters x 25 lines)

Description	Cat.No.	1-9	10+
Green	X14517	$189	$179
Amber	X14518	$189	$179

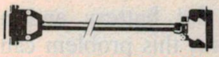


RITRON 2 MONITORS
Stylish 20MHz, non-glare 12 inch monitors available in green or amber displays and featuring swivel base that tilts forward and back and swivels right to left!
Green Cat.X14506..Normally $235
Amber Cat.X14508..Normally $239
SPECIAL, ONLY $199



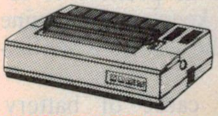
BARGAIN!

PRINTER RIBBONS
CP80, BX80, DP80, BX100, MB100
ALL A CRAZY LOW $9.95



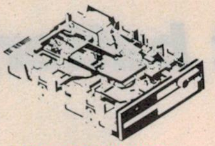
PRINTER LEAD FOR IBM*
- Suits IBM* PC XT and compatibles
- 25 pin "D" plug (computer end) to Centronics 36 pin plug

Cat.P19029 1.8 metres $19.95
Cat.P19030 3 metres $29.95



CANON A-40 PRINTER
- Serial Impact Dot Matrix
- 140 C.P.S
- Near Letter Quality Mode
- 1.4K Buffer

Cat. C20040 .... **$595**



NEC DISK DRIVES

3½" DISK DRIVE
- 1 M/Byte unformatted, (640K formatted),
- Double sided, double density,
- Access Time 3m/sec

Cat. **$265**

5¼" SLIMLINE
- Switchable 1.6 M/Byte to 1 M/Byte unformatted 1.2 M/Byte to 720K formatted
- Double sided, double density,
- AT compatible

Cat. C11906 .... **$295**

8" SLIMLINE
- Double sided, double density,
- 1.6 M/Byte unformatted.

Cat. C11908 .... **$795**

1 YEAR WARRANTY!

IBM* COMPATIBLE DISK DRIVES
Tired of paying out more for Japanese Disk Drives? These "direct import" Hong Kong disk drives are the solution! They feature Japanese mechanical components, yet cost only a fraction of the price!

Cat.No.	Description	Price
C11801	500K	Normally $199
		SPECIAL, ONLY $179
C11803	1 M/Byte	$239
C11805	1.6 M/Byte	$259

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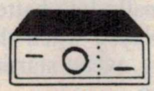
20 M/BYTE HARD DISK DRIVE FOR IBM* AND COMPATIBLES
NEC drive with DTC controller card.
Cat. X20010 .... WAS $995
SPECIAL, ONLY $895
*IBM is a registered trade mark.

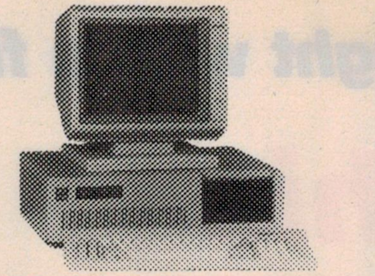


2 & 4 WAY RS232 DATA TRANSFER SWITCHES
If you have two or four compatible devices that need to share a third or fifth, then these inexpensive data transfer switches will save you the time and hassle of constantly changing cables and leads around.
- No power required
- Speed and code transparent
- Two/Four position rotary switch on front panel
- Three/Five interface connections on rear panel
- Switch comes standard with female connector

2 WAY Cat.X19120 ~~$125~~ $95
4 WAY Cat.X19125 ~~$145~~ $135

2 & 4 WAY CENTRONICS DATA TRANSFER SWITCHES
Save time and hassles of constantly changing cables and leads around with these inexpensive data transfer switches. These data switches support the 36 pin centronic interface used by Centronics, Printronics, Data Products, Epson, Micronics, Star, and many other printer manufacturers.
- No power required
- Speed and code transparent
- Two/Four position rotary switch on front panel
- Three/Five interface connections on rear panel
- Switch comes standard with female connector
- Bale locks are standard

2 WAY Cat.X19130 ~~$125~~ $95
4 WAY Cat.X19135 ~~$145~~ $135



IBM* XT COMPATIBLE COMPUTERS from $795*

Check these features and our prices. We're sure you'll agree they're exceptional value for money!

- Assembled in Australia!
- Tested by us for 24 hours prior to delivery!
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- AT style keyboard
- Operating manual
- 8 Slot motherboard
- 6 Months warranty!

(Japanese drives available for an extra $50 each)

* $795 COMPATIBLE COMPUTER
256K RAM Single Drive, Graphics and Disk Controller Card. $795

256K RAM COMPATIBLE COMPUTER
2 x 360K Disk Drives, Multifunction Card, Colour Graphics, Disk Controller, 1 Parallel Port. (Includes Timer Disk) $1,095

640K RAM COMPATIBLE COMPUTER
2 x 360K Disk Drives, Multifunction Card, Colour Graphics, Disk Controller, 2 Serial, 1 Parallel Port. (Includes Timer Disk). $1,195

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20 M/Byte Hard Disk, 360K Disk Drive(s), 640K RAM, Multifunction Card, Colour Graphics, Disk Controller, 2 Serial, 1 Parallel Port. (Includes Timer Disk)
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- Floppy & Hard Disk Controller
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.... only $3,395

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MICRODOT 5¼" DISKS!

DESCRIPTION	1-9 BOXES	10+ BOXES
5¼" S/S D/D	$14.95	$13.95
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(SEND $2 FOR SAMPLE DISK!)

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$49.95 (PER 10 DISKS)	$44.95 (PER 10 DISKS)	$39.95 (PER 10 DISKS)

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Bulked packed, Microdot D/S D/D without boxes, or brand name, just their labels and white card jacket!

1-99 DISKS	100+DISKS	1,000+DISKS
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(SEND $2 FOR SAMPLE DISK!)
(TAX EXEMPT PRICES LESS 20¢ PER DISK)

3½" "NO FRILLS" DISKS!
D/S D/D disks with white boxes and labels but no brand name. (These are a top name brand, but we can't tell you which.)

10-99 DISKS	100+DISKS	1,000+DISKS
$47.50 (PER 10 DISKS)	$45.50 (PER 10 DISKS)	$42.50 (PER 10 DISKS)

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All prices 10 disk boxes!

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MAIL ORDER HOTLINE
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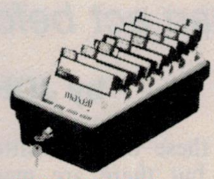

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Features...
- 100 disk capacity
- Smoked plastic cover
- Lockable (2 keys supplied)
- 9 Dividers/spacers

C16020 .... only $24.95
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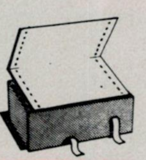
5¼" DISK STORAGE
Efficient and practical. Protect your disks from being damaged or lost!
Features...
- 70 disk capacity
- Smoked plastic cover
- Lockable (2 keys supplied)
- Dividers/spacers

Cat. C16025 ...... only $19.95



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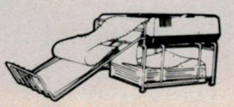

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- Restores order to the top of your desk or work area
- Made of white plastic coated steel
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- Allows easy examination of print out

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IBM* XT COMPATIBLE CARDS
NEW! NEW! NEW! NEW!

20M/BYTE HARD DISK CARD
XT compatible, simply plugs straight in to your computer!
Cat. $1,295

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Cat. X18002 .... $129

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(AT COMPATIBLE)

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MasterCard VISA

Don't get caught with a flat battery

Build this car battery monitor

A flat battery is inconvenient to say the least. This simple electronic voltmeter lets you monitor the condition of your car's battery so that you can act before getting stranded.

by JOHN CLARKE

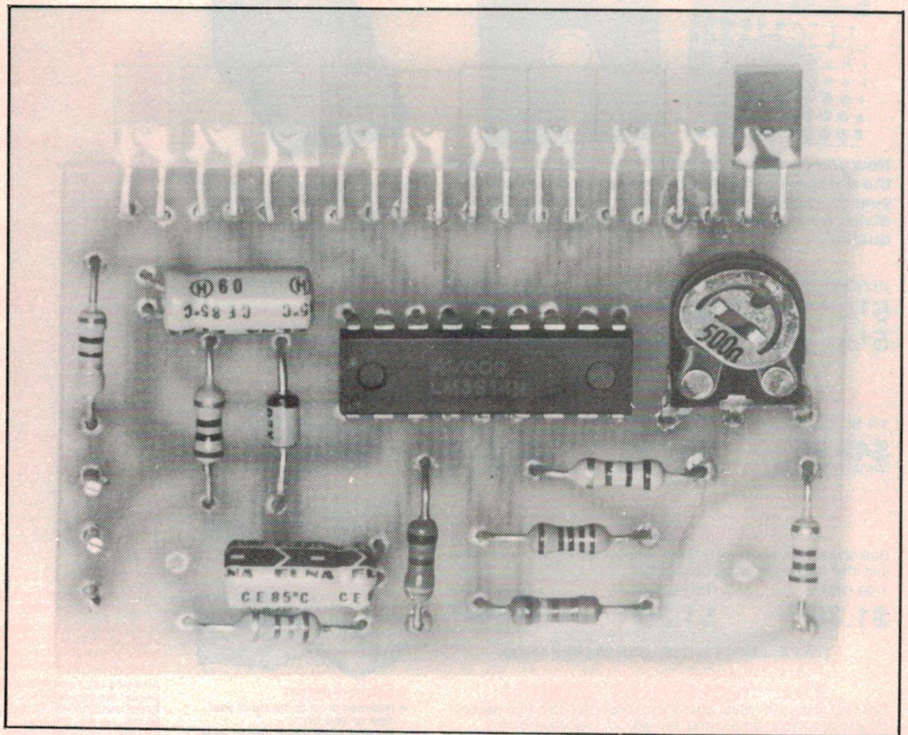
Most new cars these days are fitted with a voltmeter but there are many older cars (and still quite a few new ones) which lack this important accessory. A voltmeter allows you to monitor the condition of your car's battery and will quickly show up potential problems.

By far the most useful sort of voltmeter is the expanded scale type, with a range from about 11-15V DC. With this type of voltmeter, you can tell at a glance whether the battery is charged correctly, whether it is overcharging, or whether its voltage is low.

Our new Car Battery Monitor is of the expanded scale type but, instead of using an expensive mechanical meter with suppressed zero, it is fully electronic. The readout consists of 10 rectangular LEDs arranged as a bar graph. Three different LED colours are used to indicate "low", "normal" or "overcharging".

The first three LEDs in the sequence are yellow and these indicate the low condition, ranging from 11-12V (approx). Following these are six green LEDs which indicate the normal range from 12-14.4V. A single red LED completes the lineup and lights when the battery voltage exceeds 14.4V to indicate overcharging.

If the battery voltage is less than 11V, none of the LEDs light and you've really got trouble.



The trimpot is adjusted so that the red LED lights when the voltage reaches 14.4V.

What to look for

One of the most frustrating battery problems is when the vehicle will not start because the battery voltage is too low. The symptoms are easy to recognise: the motor struggles to turn over when cranked and refuses to "fire" because the ignition system cannot provide a satisfactory spark.

This problem could be due to a faulty cell in the battery or, alternatively, a bad battery contact. Quite often, a battery monitor will reveal any such faults before they become serious enough to disable the vehicle. Initially, an abnormally low battery voltage would be displayed when the battery is under load; eg, when starting or with the headlights on.

A more subtle battery problem can occur on a rainy night with the headlights, windscreen wipers, ventilation fan and other accessories all operating. If, in these conditions, the engine spends long periods at idle, as in heavy traffic, the alternator may not be able to cope with the load.

The result is a flat battery and a stalled car. As before, this problem can be prevented by monitoring and acting on the fall in battery voltage. In this case, it's simply a matter of turning off as many accessories as possible to reduce the load, and keeping the engine at a fast idle while the vehicle is stationary.

Another possible cause of battery problems is a broken alternator belt.

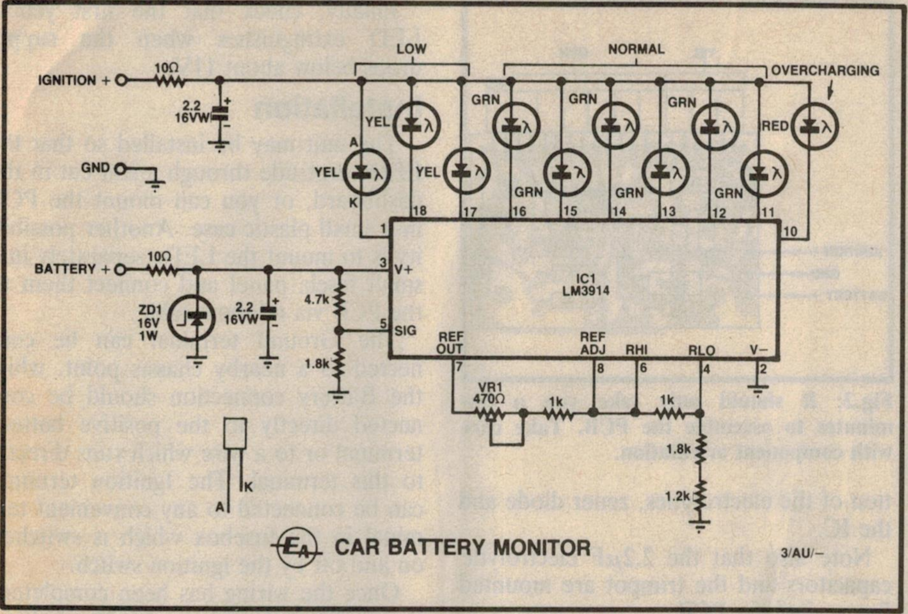


Fig.1: the circuit is based on an LM3914 dot/bar display driver IC.

While this problem should be immediately indicated by the alternator warning light, the battery monitor can provide useful reinforcement to alert the driver.

Finally, the battery monitor will detect if the regulator is faulty. If the regulator does not limit the voltage of the battery to 14.4V, then the final LED on the monitor will light to indicate overcharging. Note that overcharging will eventually lead to battery overheating, resulting in water loss and damaged cells.

How it works

The circuit is very simple and is based on an LM3914 dot/bar display driver IC. This IC monitors the analog input voltage and indicates the level on a LED display.

In this circuit, pin 9 has been left open circuit so that the IC operates in dot display mode; ie, it lights only one LED at a time. Alternatively, the IC can be made to operate in bar mode by connecting pin 9 to V+ (pin 3). In this mode, a column of LEDs will light to indicate the battery voltage.

Let's assume that the IC is wired in the dot display mode, as in our circuit. Here's what happens:

The incoming battery voltage is fed via a 10Ω resistor to pin 3 and is also clamped by 16V zener diode ZD1 which removes any potentially damaging voltage spikes. The voltage on pin 3 is then fed to a voltage divider network (4.7kΩ and 1.8kΩ) to derive a signal voltage which is fed to pin 5.

This signal voltage is equal to the reference high (RHI) input on pin 6 when the battery voltage is 14.4V, and equal to the reference low (RLO) input on pin 4 when the battery voltage is 10.8V.

What this means in practice is that the LEDs only light for input voltages greater than 10.8V. As soon as the 10.8V level is exceeded, the first yellow LED in the series lights. Each LED then lights in turn and the previous LED goes out as the battery voltage increases. The final LED in the sequence at pin 10 lights when the battery voltage exceeds the RHI voltage on pin 10.

The reference voltages are set using the Ref Out voltage at pin 7 to source current to a voltage divider consisting of a 1kΩ resistor between RHI and RLO and a 3kΩ resistor (1.2kΩ and 1.8kΩ in series) from RLO to ground.

The series 1kΩ resistor and 470Ω trimpot between Ref Adj and Ref Out set the current through the voltage divider to about 1mA. This gives the required 3V at RLO and 4V at RHI.

The supply for the LED anodes is derived from the ignition switch and decoupled with a 10Ω resistor and 2.2μF capacitor. Note, however, that the supply for IC1 is derived directly from the battery. This arrangement is used so that the circuit will not be affected by any voltage drop between the battery and ignition switch.

Construction

The parts for the Car Battery Monitor are all mounted on a small PCB coded 87vm3 and measuring 58 x 39mm. Follow the overlay diagram (Fig.2) carefully when installing the parts on the PCB and note the orienta-

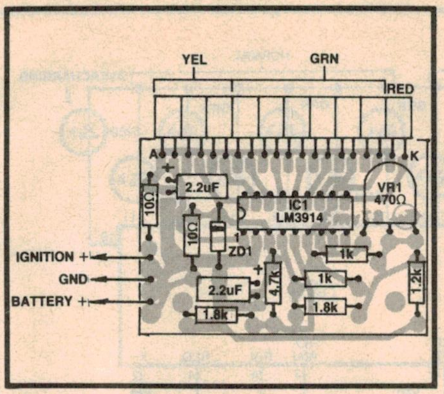


Fig.2: it should only take you a few minutes to assemble the PCB. Take care with component orientation.

tion of the electrolytics, zener diode and the IC.

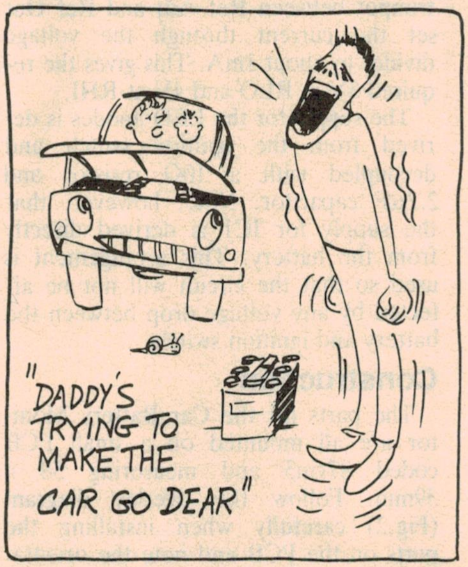
Note also that the 2.2μF electrolytic capacitors and the trimpot are mounted flat against the PCB.

The LEDs should be installed so that they all line up to make a neat display. Make sure that they are all oriented correctly (see circuit diagram for pinouts) and initially solder only one lead first so that they can be easily adjusted. Once the LEDs are correctly aligned, the remaining leads can be soldered.

We used PC stakes for the three wiring terminal points, but these can be considered optional.

Testing

To test the unit, you will require a variable power supply (11 to 15V) and a multimeter. Connect the Ignition and Battery terminals of the monitor to the supply positive, and the Ground terminal to supply negative. This done, connect your multimeter across the power supply and adjust VR1 so that the red LED just lights at 14.4V.



Finally, check that the first yellow LED extinguishes when the supply drops below about 11V.

Installation

The unit may be installed so that the LEDs protrude through a slot cut in the dashboard, or you can mount the PCB in a small plastic case. Another possibility is to mount the LEDs separately in a small fascia panel and connect them to the PCB via rainbow cable.

The Ground terminal can be connected to a nearby chassis point, while the Battery connection should be connected directly to the positive battery terminal or to a wire which runs directly to this terminal. The Ignition terminal can be connected to any convenient terminal in the fusebox which is switched on and off by the ignition switch.

Once the wiring has been completed, the monitor should display the battery voltage whenever the ignition is on. Make sure that you don't disturb the setting of VR1 during installation otherwise you'll upset the reference voltages.

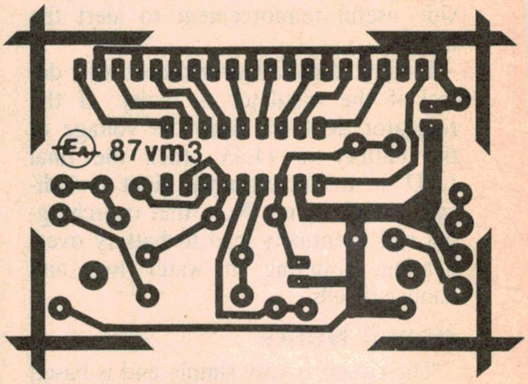


Fig.3: actual size PCB pattern. You can either etch your own board or buy a ready-etched board from from the usual retail outlets.

PARTS LIST

- 1 PCB, code 87vm3, 58 x 39mm
- 6 green rectangular LEDs
- 3 yellow rectangular LEDs
- 1 red rectangular LED
- 1 LM3914 dot/bar display driver IC
- 1 16V 1W zener diode
- 3 PC stakes
- 2 2.2μF 16VW PC electrolytic capacitors
- 1 4.7kΩ 0.25W resistor
- 2 1.8kΩ 0.25W resistors
- 1 1.2kΩ 0.25W resistor
- 2 1kΩ 0.25W resistor
- 1 470Ω miniature vertical trimpot
- 2 10Ω 0.25W resistors

AUSSAT: the best is yet to come

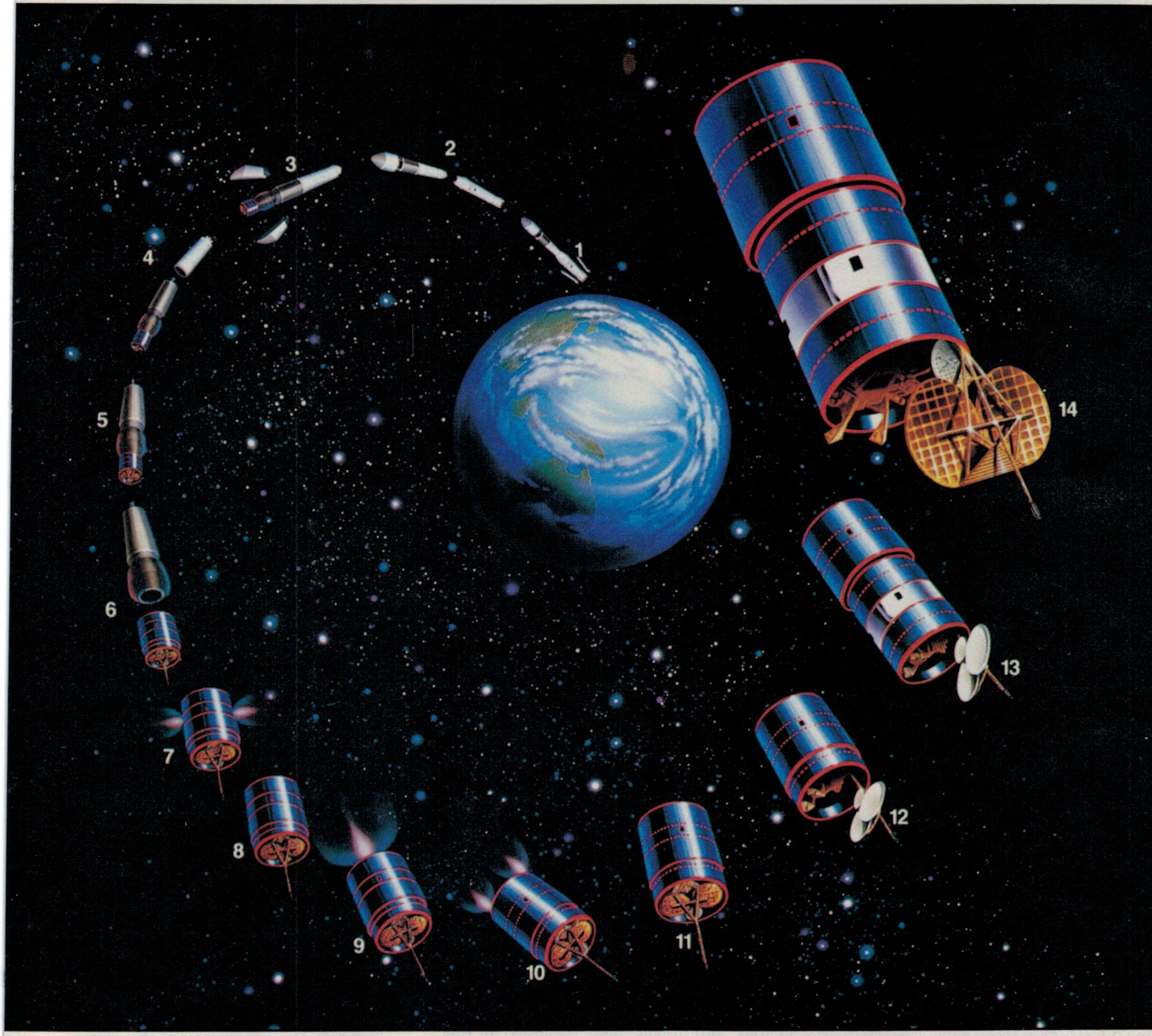
Launched by US Space Shuttles during August and November 1985, Australia's two Aussat communications satellites have proved to be a big success. A third satellite will be launched shortly and plans are well under way for the next generation of spacecraft.

by TERRY AYSCOUGH

AUSTRALIA'S first communications satellite, Aussat 1, was launched from the US Space Shuttle *Discovery* on 28 August, 1985. This was followed four months later, on 27 November, 1985, by Aussat 2, which was carried aloft by Space Shuttle *Atlantis*.

The original plan was for a third satellite, Aussat 3, to be lifted into orbit by the unmanned European *Ariane*

Aussat has brought TV to isolated communities and outback homesteads throughout Australia. A small dish antenna is required to receive the satellite signal.



This artist's representation shows the 14 operations necessary to successfully launch Aussat 3 via Ariane rocket. The spacecraft must be correctly oriented in geosynchronous orbit, northeast of Australia.

rocket in August last year, but technical problems with the launch vehicle have now delayed this until at least May 1987. Our large illustration shows the 14 or so operations which must all go exactly to plan for the *Ariane* launch to be successful.

In the year and a half since the deployment of its first two satellites, the Aussat organisation has been working flat out, signing contracts with users and getting its new services underway. Like Qantas, Australian Airlines and OTC, Aussat has been set up as a profit making commercial operation. This means that no matter how brilliant the technical achievement, it can only really succeed when a high percentage of its facilities are being used and paid for by satisfied customers.

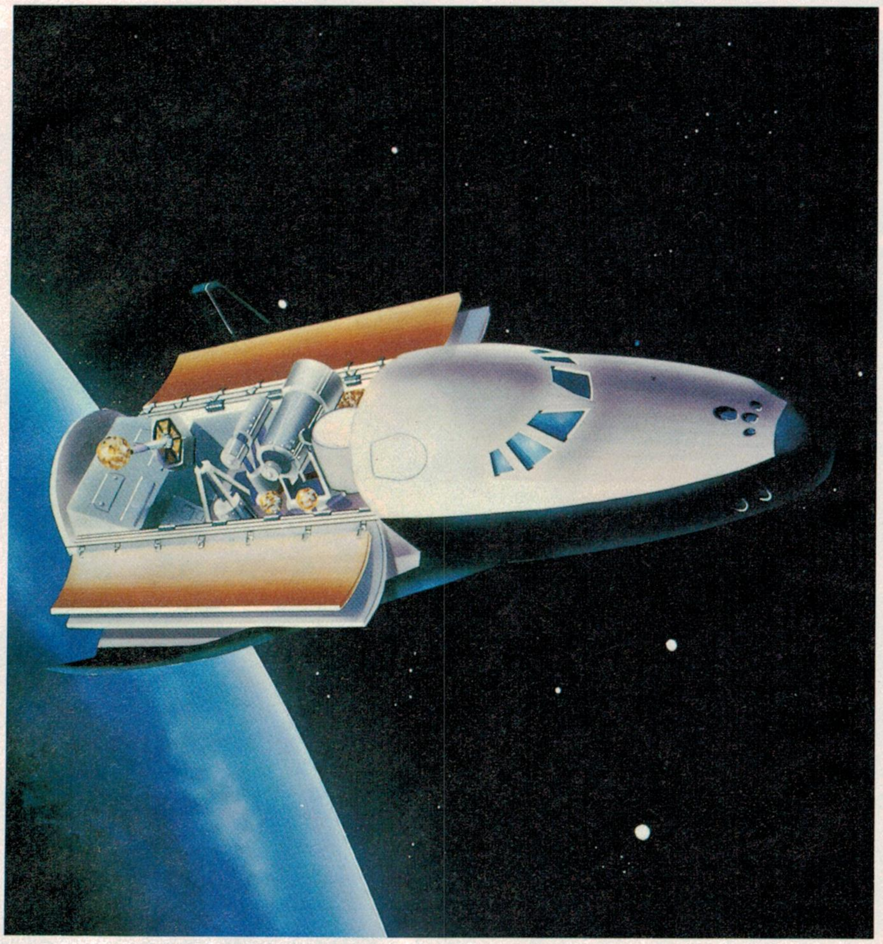
The next generation

Assuming that no mechanical or electrical failures occur, the life of each satellite is determined by the amount of fuel which is carried on board for the station keeping thrusters and the rate at which this is used up while in orbit. When the thrusters can no longer be activated, the satellite will drift out of position and lose its correct orientation, making it useless for communications.

By the time this article appears in print, both Aussat 1 and Aussat 2 will have been in orbit for a year and a half and will have used up nearly a quarter of their useful life spans. For this reason, work is now well advanced on the design of "second generation" satellites which will last much longer, up to ten years.

Users of Aussat

The Australian Broadcasting Corporation is by far the biggest user of Aus-



France's ambitious space plans

EVEN BEFORE THE US Space Shuttle *Challenger* blew up on January 28, 1986, France was well advanced with its own plans for a manned space vehicle.

The French proposal, pictured at left, is essentially a scaled down version of the US Space Shuttle. Called *Hermes*, it is slated to fly sometime after 1995 and will be blasted into orbit atop an Ariane 5 launch vehicle, a heavy lift launcher currently under development by the European Space Agency.

Although just one of several proposals, *Hermes* probably represents the fastest and most practical way for manned European space flight. The other proposals include Britain's *Hotol* space plane (EA, Dec.1986) and West Germany's *Sanger*, a composite vehicle consisting of two vehicles piggybacked together.

In the meantime, the French have chalked up an impressive list of space successes using current generation Ariane rockets. One such success was the remote sensing *Spot* satellite which was launched from the Kourou Space Centre on February 22, 1986 by Ariane 3 (see photo at right).

sat's present facilities. It leases eight transponders on the satellites and uses satellite feeds for over 100 terrestial TV transmitters and 36 radio transmitters.

By linking the high power (30 watt) transponders to high gain antennas giving concentrated (regional) beams, it has also been possible to provide a direct broadcasting satellite (DBS) service to isolated communities and individual homesteads. This system is known by the ugly acronym of HACBSS, which stands for Homestead and Community Broadcasting Satellite Service.

In addition to the ABC national TV program, one regional and two national radio programs are also carried by HACBSS. The use of regional beams enables the programs to be provided at the correct local time.

With HACBSS signals now reaching every part of Australia plus Lord Howe and Norfolk Islands, the ABC can now justly claim to be a truly national broadcasting organisation.

In addition to the 30 watt transponders for HACBSS, the ABC also uses two 12 watt transponders with beams covering the whole of Australia for TV program transfer between studios. A portion of a third low power transponder is also used for multiple channel radio program transfer.

TV distribution

Our other national broadcaster, originally known as SBS but now to be amalgamated with the ABC, started Australia-wide satellite distribution of their programs for broadcast by terrestrial UHF stations in March last year. Cities and towns now serviced in this way include Brisbane, Hobart, Canberra, Cooma, Goulburn, Wollongong, Newcastle and Perth. The programs for Perth are time delayed before broadcast by an unmanned record/replay system, which is remotely controlled by a separate 9.6kBs satellite data link.

The major commercial TV networks (channels 7, 9 and 10) each use a single 12 watt transponder to enhance and supplement their existing networking links.

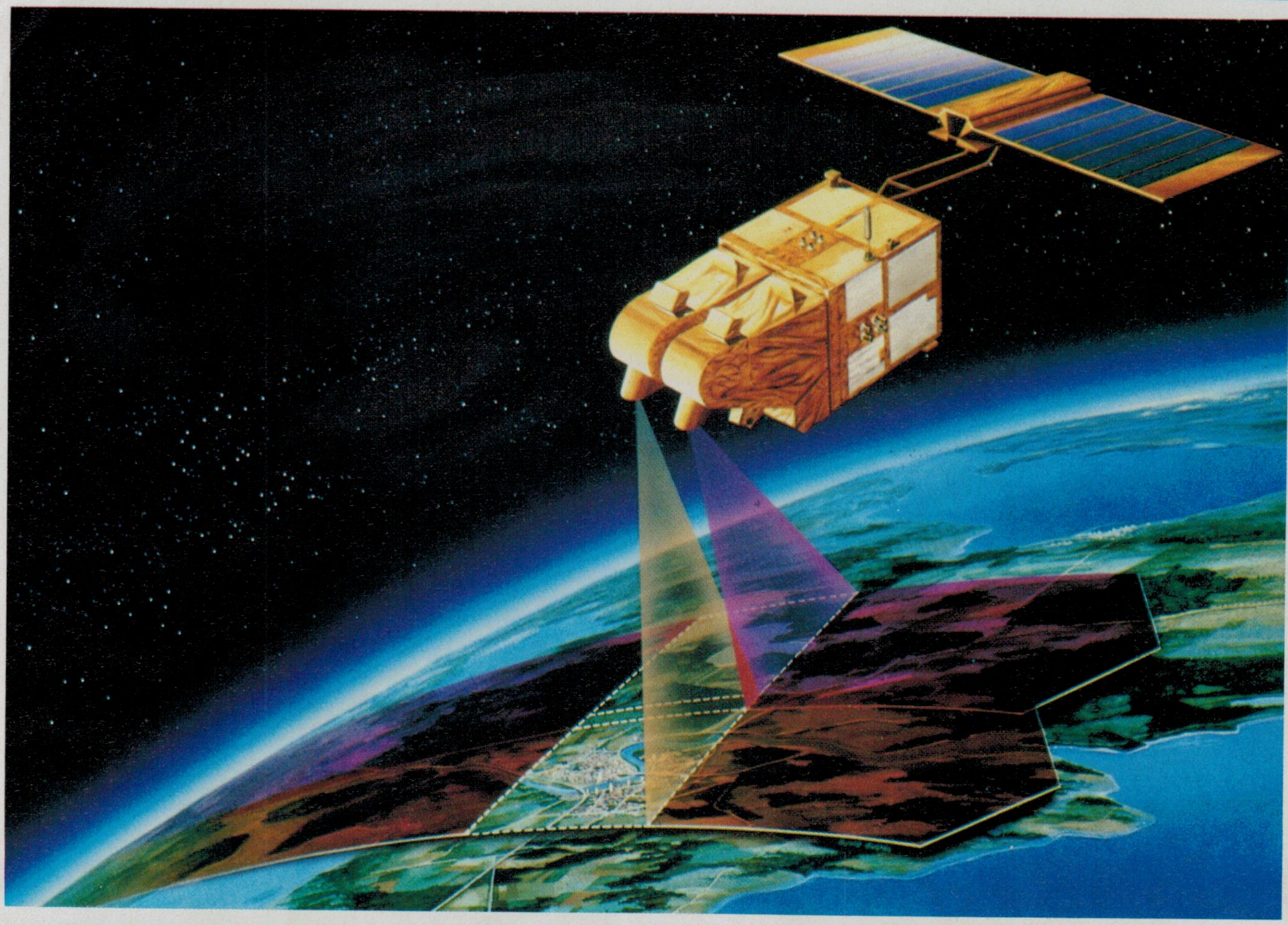
RCTS

A commercial version of the ABC's HACBSS direct broadcasting service has recently been given the go-ahead. Like HACBSS, it will use 30 watt transponders and concentrated regional beams, and can be received using the same Earth station equipment. This second program should make it much more attractive for people in remote areas to invest in an Earth station.

The new "commercial HACBSS" operation described above is officially known as Remote Commercial Television Services, or RCTS for short. At the time of writing, the only one fully up and running was WA's Golden West program, but services using the satellites' NE, SE and central beams should start operations later in 1987.

Satellite TV in clubs and pubs

Some readers will have noticed that a great many metropolitan hotels and clubs now have satellite receiving dishes. These are used to receive the special entertainment programs such as Alan Bond's *Sky Channel* or the Bell Group's *Club Superstation*. Both services were set up with breathtaking speed in mid-1986 and carry exclusive



programming based mainly on sport, news and rock music. The signals are fully encoded and can only be received by subscribers to the particular service.

By late 1986, Skychannel had placed orders for 3000 3-metre Earth stations, with NEC as the prime contractor.

Private entertainment channels of this type go under another almost unpronounceable acronym, *VAEIS*, which stands for Video and Audio Entertainment and Information Services.

The Macquarie network

Thus far, we have talked about the very heavy usage of Aussat facilities by TV broadcasters of various kinds, plus some ABC radio programs which are piggybacked onto the HACBSS signal. As well as these, stand-alone radio broadcasting can also make good use of satellites to relay news, data and programs between widely scattered studios and transmitters. The Sydney-based Macquarie Radio Network, for example, is putting together a system of this type to link its 27 owned or associated radio stations in all mainland states plus the Northern Territory.

At the present time, about 75% of Aussat's revenue comes from leasing transponders and ground station facilities to radio and TV organisations. In the longer term though, other communications and data services are expected to take up an increasing percentage of transponder capacity until usage is divided equally between radio/TV broadcasting and specialised video/data links. Let's take a look at some of these more specialised services.

AAP Reuter

The AAP Reuter News Service operates a big communications network providing data to hundreds of subscribers in major and provincial centres throughout Australia. Before Aussat, the standard structure for this kind of service consisted of a large central data bank which users could access through their own terminal and Telecom land line.

With the availability of low cost personal computers with about nine megabytes of storage capacity, it was cheaper to broadcast all available data for storage on the hard disc of each subscriber's own PC. Subscribers can then access information as and when required.

Satellites like Aussat provide ideal one-way data broadcasting circuits. In one of the several systems operated by AAP, relatively small 1.8 metre dishes are used with a broadcast data rate of 128K bits per second.

Reliability is a major concern to AAP, as any significant loss of service could prove very embarassing for subscribers such as local radio stations or newspapers.

Twice a year, the Earth's movement through space places the Sun directly behind each satellite when viewed from Earth. This results in dramatically increased RF noise levels for a few minutes. AAP say they have noted increased data error rates but have not lost the service during these periods.

Very heavy rain can also cause severe attenuation of the K-band signals to and from the satellite. This happened to AAP at their Glebe terminal in Sydney last year when services were interrupted for a total of one hour. These particular storms were the worst recorded for over 100 years, so they would be unlucky to

have the same experience again.

Overall they report that service reliability using Aussat is much better than ever proved possible with land lines and terrestrial microwave links.

MDS

As a lower cost alternative to direct reception from Aussat satellites, AAP are also pioneering the use of Multipoint Distribution Systems (MDS). These systems broadcast signals in the 2GHz band from some high point such as a tall building in the middle of a city. MDS signals are received on small, simple microstrip, parabolic or grid antennas which incorporate the head end electronics. At present, AAP has MDS systems operating in Sydney and Melbourne and there are plans to extend the service to all state capitals in the near future.

Air traffic control

Another major Aussat service that requires the highest possible system reliability is the air traffic control network operated by the Department of Aviation.

The majority of aircraft communications take place on VHF, which is restricted to "line of sight" distances for reliable operation. This has always been a problem in Australia because of the vast distances involved, and because the desolate nature of much of the terrain makes it very expensive to build and feed signals to repeater stations.

The Department of Aviation now leases four Aussat transponders and has set up a network of 45 manned and 55 unmanned Earth station sites throughout Australia. These sites include normal VHF transceivers to provide local communications with aircraft on the ground and in the air. All signals to and from the aircraft are relayed back and forth to regional flight control centres via Aussat.

It's worth noting that the entire ground-space-ground communications link is duplicated, with separate transponders on each of the two operational satellites run in parallel. This arrangement ensures the very high standard of reliability essential for aviation work.

Video conferencing

The large distances between main cities and the cost and time of travel in Australia have always made it difficult to get people together. Many companies or organisations would like to hold meetings where all their employees customers or shareholders can join in and this is now possible using interactive video conferencing via satellite.

Developments in the coding of digitised video signals have made it possible to transmit full motion colour pictures at compressed data rates in the 64Kbs to 2Mbps range. These can even be of the 1125-line high-definition TV type if required.

Low bit rate coding of high quality video images is a complicated business and uses equipment known as a Codec. Basically, the huge savings in bandwidth over conventional video circuits are achieved by transmitting only information which differs significantly from frame to frame, or for parts of a picture where continuing motion is detected.

Many hotels and conference centres in state capitals now have permanently installed satellite link antennas for video conferencing, whilst mobile units (a dish on wheels) can be towed to almost any location. Newly emergent companies vying for a slice of the rapidly growing market include Australian Satellite Express, Lend Lease Communications, Network Technologies and the Australian Meeting Channel.

Q Net

Federal and State Governments are also showing keen interest in Aussat, with Queensland leading the way with its Q Net information technology sys-

Communications Satellites

Communications satellites like Aussat are placed into geosynchronous orbits 36,000 kilometres above the equator. At this height, they take exactly 24 hours to complete one orbit. This means that they turn at the same speed as the Earth and appear to remain at the same point in the sky, although in practice there is some drift. For this reason, small thruster rockets are fired from time to time to keep the spacecraft on station and to maintain the correct attitude relative to Earth.

All three Aussat satellites are powered by solar cells, backed up by nickel-cadmium batteries. A triple reflector antenna system provides a selection of different receive and transmit beams as shown.

Each satellite has 15 channels which pick up signals directed from Earth stations on frequencies in the range 14-14.5GHz. These signals are frequency changed to the range 12.25-12.75GHz. This combination of frequencies is known as Ku band. After being frequency changed, the signals are amplified by either 12 or 30 Watt travelling wave tubes (TWTs). The receiver, frequency converter and TWT are collectively known as a "transponder".

A ground-controlled switching system aboard the spacecraft can connect transponders to one of four high gain spot beam antennas, as shown, or a lower gain national beam which covers the whole of Australia.

AUSSAT'S SATELLITE COVERAGE AREAS

NATIONAL BEAM

WESTERN AUSTRALIA BEAM

SOUTH EAST BEAM

CENTRAL AUSTRALIA BEAM

NORTH EAST BEAM

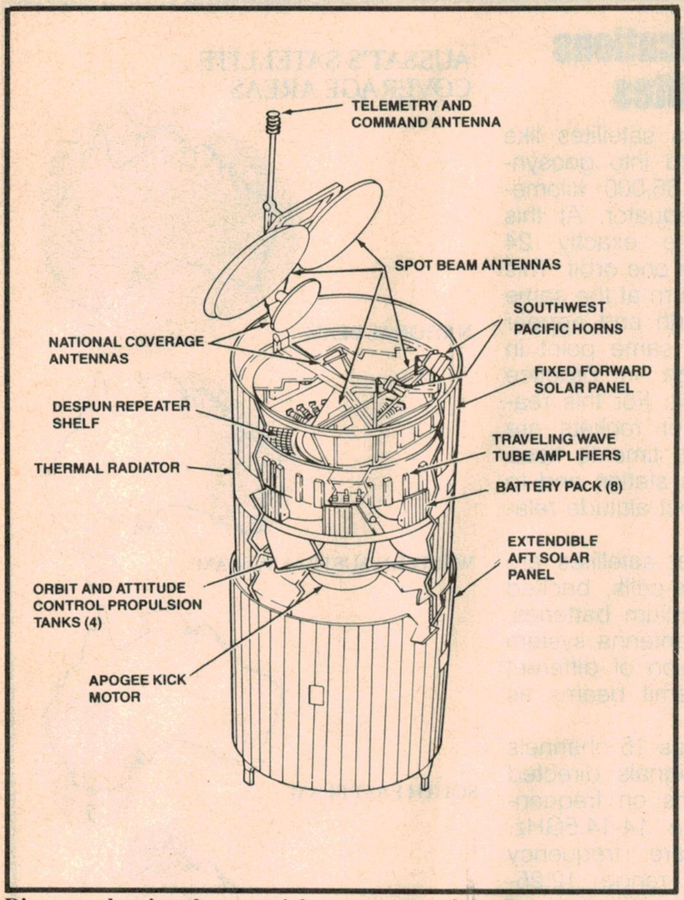
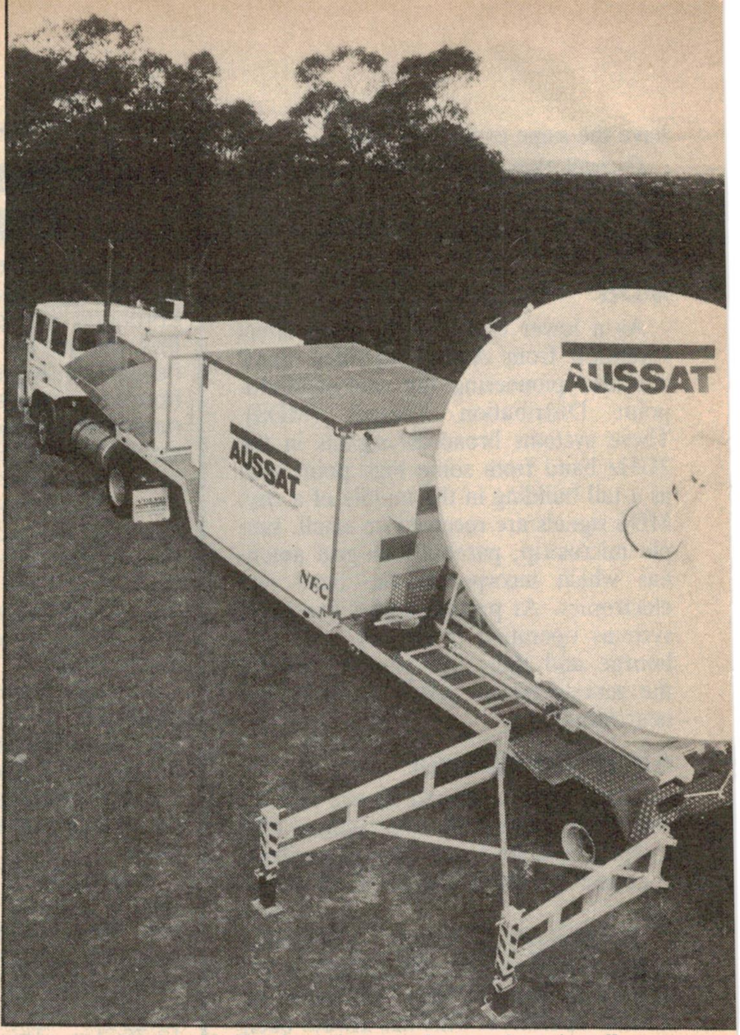


Diagram showing the essential components of the first generation Aussat satellites. The satellites operate in the 12/14GHz Ku band and have an operational life of 8-10 years.



Aussat transportable Earth stations can be towed to virtually any site in Australia. The stations may be used by commercial organisations such as mining companies, or to cover special events.

tem. Q Net is a very flexible and versatile communications network, capable of handling voice, data and video.

By June 1987, 120 Earth stations will be operational throughout the state. Trial applications include medical diagnostic services, hospital information products, a videotex system, training for nurses, school of the air programs extending from primary level up to adult further education, automatic river level monitoring, railway signalling and a helicopter transportable Earth station for use in major emergencies.

Mining

Some of the most enthusiastic users of Aussat include oil and mining exploration companies. Their main need is for voice, facsimile and data communications between remote sites and head office, which is usually in one of the state capitals. Secondary needs include contact with suppliers and contractors, plus normal telephone links to friends and relations. If direct TV reception of HACBSS or RCTS can be included, so much the better.

A competitive industry is springing up to provide transportable Earth station equipment which meets these needs. Dish sizes ranging from 2.4 to 4.6 metres are normally used and the smaller sizes can be trailer mounted for towing behind ordinary four wheel drive vehicles.

Aussat can provide as much or as little link capacity as required. This might range from one tenth of one precent of a transponder for a simple two channel telephone circuit, up to a full transponder if very high speed multiple channel data and facsimile are required.

Iterra

Although the Telecom terrestrial network and Aussat's space system compete for business in some areas, the two organisations work together to provide Telecom's Iterra service. Iterra sounds like yet another confusing acronym, but in fact is an Aboriginal word meaning "be quick".

Telecom's Iterra Network Service (INS) is designed to provide metropolitan-quality telephone and other services in remote areas, where existing facilities are inadequate or non-existent. The speed with which a satellite link can be set up is exploited by Iterra's transportable Earth stations, which have provided communications from very remote areas for special events such as car rallies, etc.

The Iterra Business Service (IBS) is intended specifically for commercial users and gives point to point data links at various speeds, plus voice, video and text as required. The transportable Earth station facilities are particularly useful for commercial ventures which frequently move their base of operation. These include mineral exploration teams and construction groups working on outback tourist developments etc.

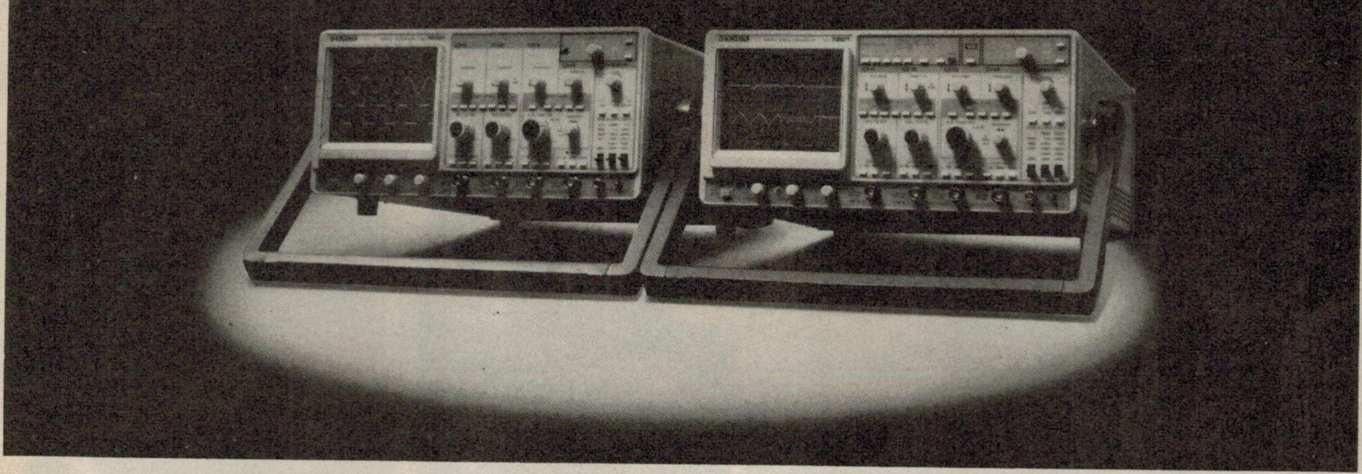
Small users

An area of great promise for the future is for a multiplicity of small users to share part of a transponder's total capacity. This idea is being actively promoted by Aussat and many local companies are bringing economically priced Very Small Aperture Terminals (VSATs) and other hardware onto the market.

Second generation Aussats

Aussat 1 is due to be retired from service in March 1993 and Aussat 2 in January 1994. Assuming that Aussat 3 is successfully launched in May as

The Complete Instrument



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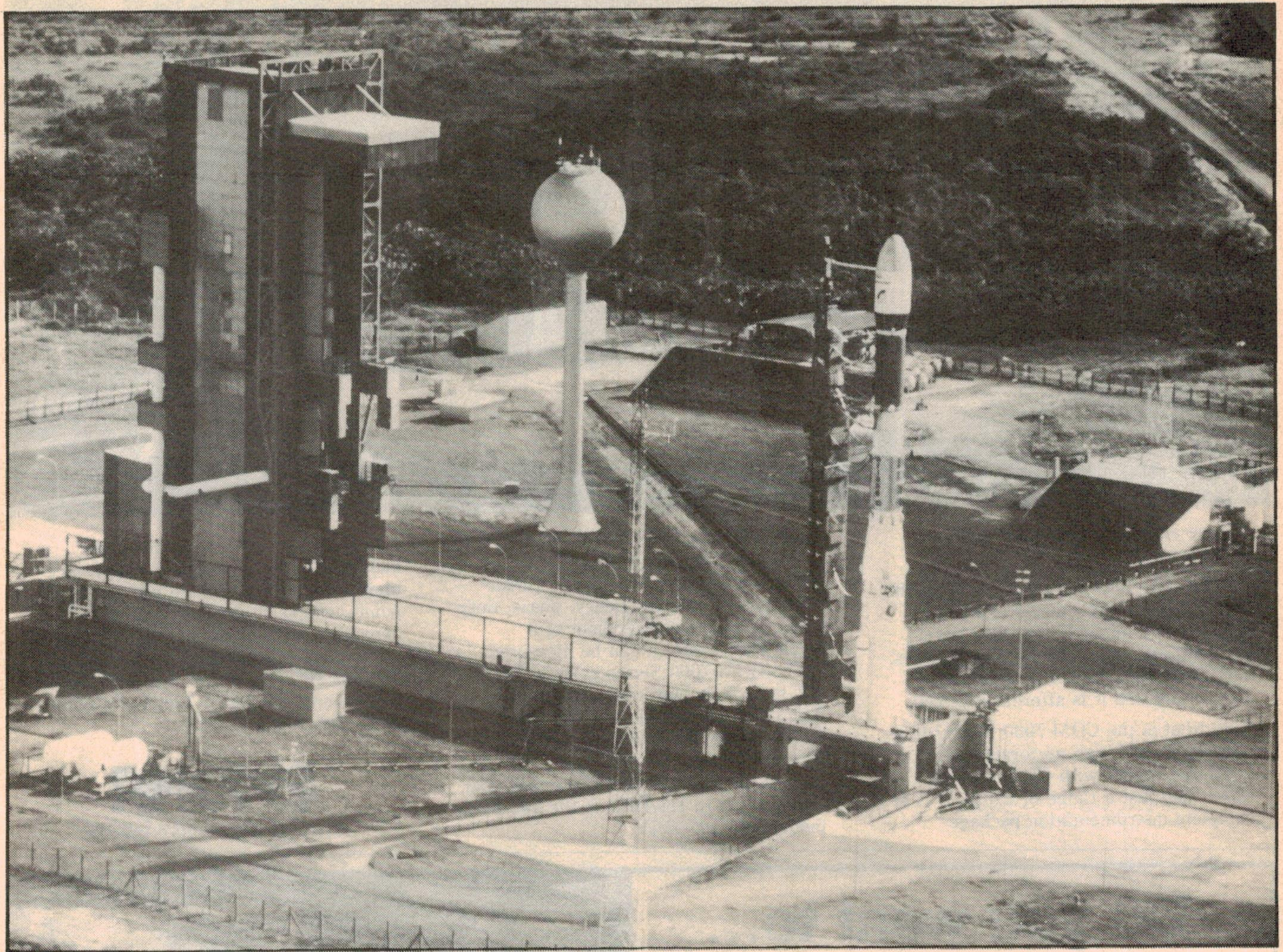

Aussat 3 is scheduled for launch by Ariane rocket during May from this launch site near Kourou in French Guiana.

planned, it should remain operational until early 1997.

In February this year, a meeting was held in Sydney to brief industry on Aussat's requirements for its second generation of satellites. The first two of these will be launched in the early 1990s as replacements for Aussats 1 and 2, while a third will be launched in 1997 to take over from Aussat 3.

The first generation satellites each have 15 14/12 GHz (Ku band) transponders. Of these, there are four high power transponders operating at 30 watts and 11 medium power transponders running at 12 watts. Each transponder has a maximum usable bandwidth of 45MHz.

The second generation spacecraft will each have 19 high power 14/12GHz (Ku band) transponders. Fifteen of these will be linked to antennas giving spot or national coverage beams, while the remaining four will feed beams specifically tailored to cover New Zealand. The New Zealand transponders will also be capable of parallel operation to give really high power DBS signals. A provision for cross connecting two NZ transponders with two Australian transponders will also be included, so trans-Tasman traffic can be handled if required.

A completely new feature on the second generation satellites will be the inclusion of an L band transponder on each spacecraft. This will receive on 1646.5 to 1660.5MHz and transmit on 1545 to 1559MHz, but will be cross-strapped to the Ku band system. The complete set up will provide a capability for road, sea and air mobile stations to transmit to and receive from the satellite using simple antennae. Base stations, however, will continue to link up and down using the more sophisticated antenna systems required for Ku band.

Several hundred voice channels will be handled by the one L band transponder. Typical applications might include an Australia-wide overlay to augment the new cellular mobile radio network; direct telephone communications for ships, aircraft etc; or special facilities for police, emergency services and search and rescue operations. A position fixing system with an accuracy of 1-2km is also to be included.

Other interesting options being considered include room for scientific equipment packages such as beacon transmitters operating on VHF, UHF, L and Ka bands, a laser retroreflector to aid mapping, an energetic particle detector, and a magnetometer.

The increase in the number and power of transponders, more elaborate antenna systems, provision for scientific payloads, and an increase in service life from seven to 10 years all mean that bigger and more powerful spacecraft will be necessary. The first generation satellites have solar panel arrays capable of generating just over 1000 watts of electrical power and have an "on station" weight of less than 700 kilograms.

It is expected that the second generation craft will generate about 3000 watts and weigh roughly 2500 kilograms. These figures clearly show that the new Aussats will be much bigger than their present day cousins.

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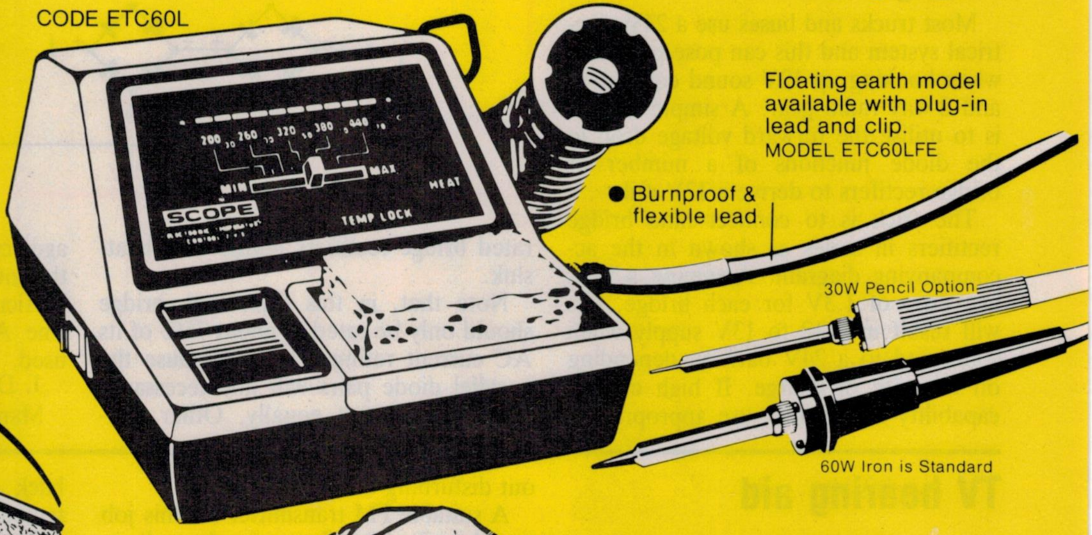

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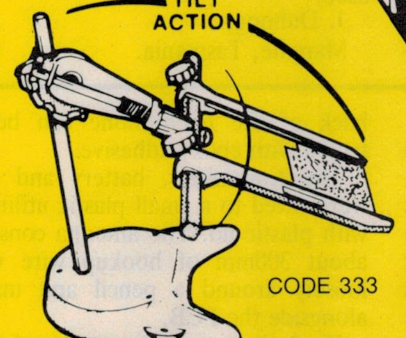

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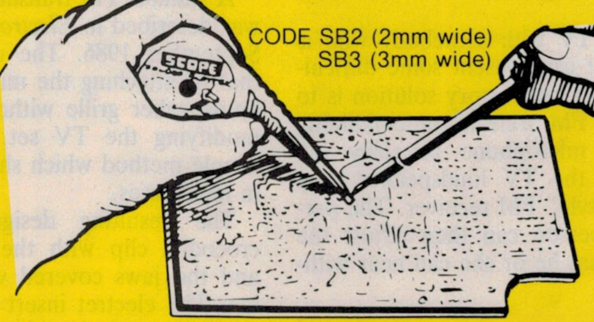

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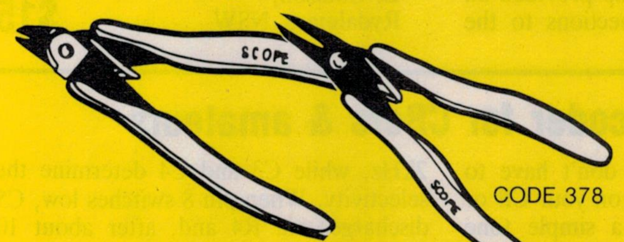

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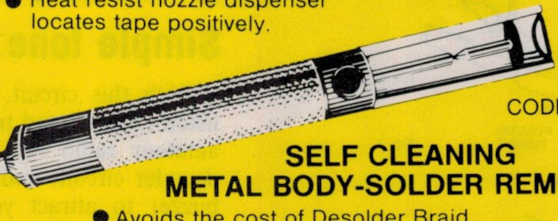

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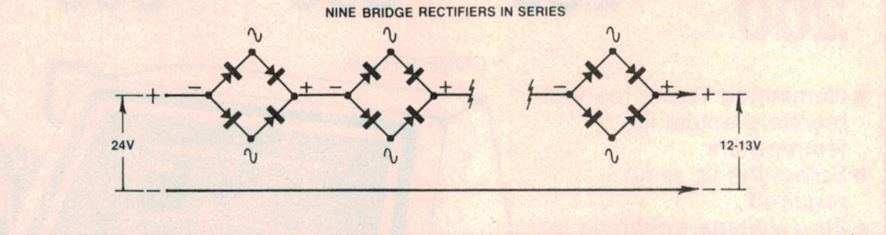
Circuit & Design Ideas

Interesting circuit ideas from readers and technical literature. While the material has been checked for feasibility, the circuits have not been built and tested by us. As a consequence, we cannot accept responsibility, enter into correspondence or provide constructional details.

Crude but simple voltage reducer



Most trucks and buses use a 24V electrical system and this can pose problems when hooking up 12V sound equipment and 2-way radio gear. A simple answer is to utilise the forward voltage drop in the diode junctions of a number of bridge rectifers to derive a 12V rail.

The trick is to connect nine bridge rectifiers in series as shown in the accompanying diagram. Assuming a voltage drop of 1.3V for each bridge, this will result in a 12 to 13V supply when connected to a 24V battery, depending on its state of charge. If high current capability is required, use appropriately rated bridge rectifiers bolted to a heatsink.

Note that, in this role, each bridge should only be rated at about 75% of its AC current rating. This is because the parallel diode pairs will not necessarily share the current equally. Other voltages can be derived by simply adjusting the number of bridge rectifiers. Note particularly the method of connection. The AC inputs of the bridges are not used.

J. Dehoog,
Margate, Tasmania. **$10**

TV hearing aid

Watching TV with somebody who is partially deaf can present some difficulties. The most satisfactory solution is to use a small FM transmitter containing an electret microphone to relay the sound from the TV loudspeaker to a "Walkman-style" FM receiver. The partially deaf person can then adjust the volume so that he or she can hear without disturbing other viewers.

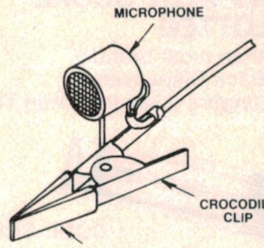


Fig. 1

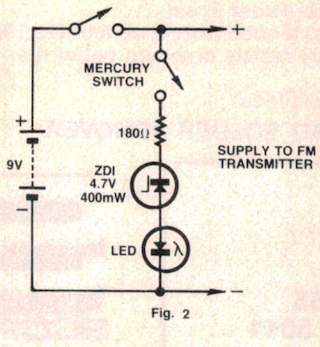


Fig. 2

A suitable FM transmitter for this job was described in *Electronics Australia* in September 1986. The only problem is that of attaching the microphone to the loudspeaker grille without damaging or modifying the TV set. Fig.1 shows a simple method which should be suitable in most cases.

The resulting design comprises a crocodile clip with the teeth filed off and the jaws covered with PVC sleeving. The electret insert is soldered to a short piece of wire 15mm long and faces towards the jaws as shown. The lead is clamped in the cable clamp provided on the clip, while the connections to the back of the microphone can be protected with epoxy adhesive.

The transmitter, battery and switch were fitted to a small plastic utility case with plastic lid. The antenna consists of about 300mm of hookup wire wound loosely around a pencil and installed alongside the PCB.

Fig.2 shows an arrangement for testing the battery. When the unit is picked up, the mercury switch closes and lights the LED if the battery condition is satisfactory. The LED also serves as a reminder to switch the unit off with the power switch after use.

B. Coulson,
Rydalmere, NSW. **$15**

Simple tone decoder for CBers & amateurs

With this circuit, you don't have to listen to unwanted traffic on your CB or amateur radio rig. It's a simple tone decoder circuit, and is used to switch a buzzer to attract your attention when the wanted call is received.

The circuit switches only when a 2kHz tone is received for a period of five seconds or more. The audio input for the tone decoder is derived from the extension loudspeaker socket on the rig and is coupled via R4 and C4 to an NE567 tone decoder IC (IC1). When the correct tone is received, the output of the tone decoder (pin 8) switches low.

R3, together with R2 and C2, sets the centre frequency of the tone decoder to 2kHz, while C3 and C4 determine the selectivity. When pin 8 switches low, C5 discharges via R4 and, after about 10 seconds (assuming the tone continues to be received), pulls pin 2 of IC2 below 1/3Vcc.

IC2 is a 555 timer IC wired as a monostable. Its pin 3 output immediately switches high when pin 2 drops below 1/3Vcc, and remains high until the voltage on pin 2 rises to 2/3Vcc (ie, when C5 recharges at the end of the tone period). This turns on Q1 which, in turn, activates the relay.

The relay contacts are used to activate a suitable warning circuit; eg, a buzzer, a bell, or even a flashing light. Note that, because of the time constant

16K Memory for VZ-300 Computer

This 16K expansion can be built for considerably less than commercial versions. It comprises two 8K x 8 6264 CMOS static RAMs, a 74HC138 1-of-8 decoder and a 4008 4-bit adder.

IC3 and IC4 provide decoding of the A11 to A14 memory addresses to select IC1 and IC2 via the CS1-bar chip select inputs. The Y0 and Y1 outputs of IC3 ensure that when IC1 is selected IC2 is deselected and conversely, when IC2 is selected IC1 is deselected. A15 is used to select both IC1 and IC2 via the CS2 chip selects.

The MREQuest-bar line is used to enable IC3 via the G2A-bar and G2B-bar inputs.

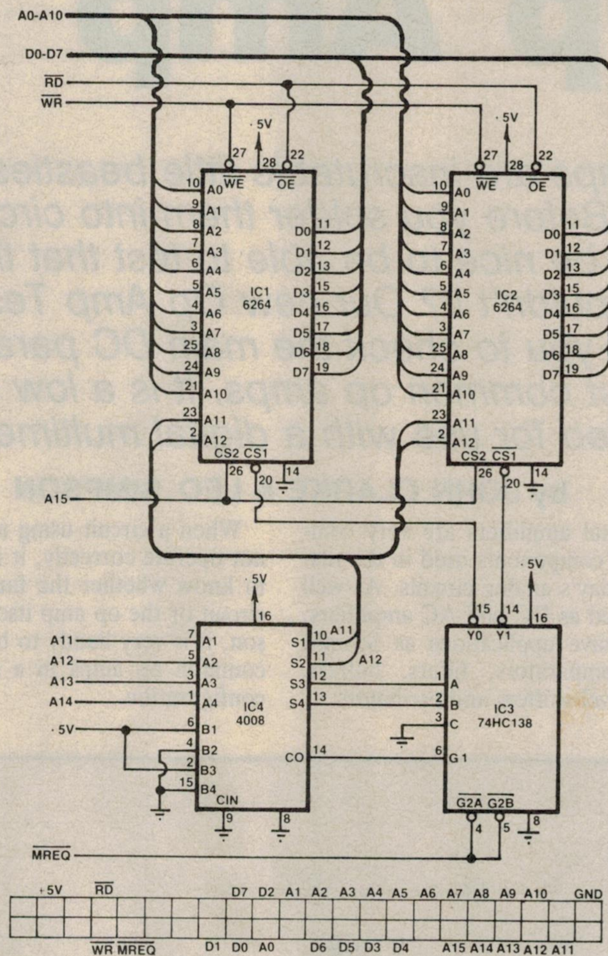
Read and Write (RD-bar and WR-bar) lines select the Write Enable-bar (WE-bar) and Output Enable-bar (OE-bar) of both IC1 and IC2.

Data lines D0 to D7 connect to the D0 to D7 lines of both IC1 and IC2. For the memory, A0 to A10 connect directly to the A0 to A10 lines of IC1 and IC2, while A11 and A12 connect via IC4.

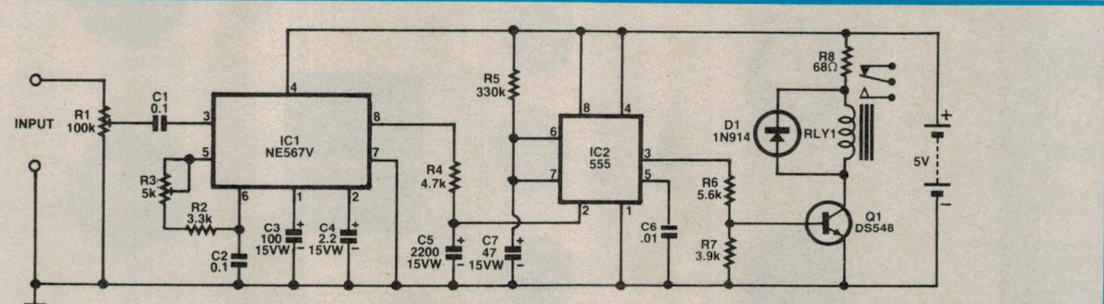
Construction can be wire wrap or on Veroboard. A 44-way 2.54mm (0.1 inch) edge connector connects the memory expansion to the VZ-300 computer. The connections for this bus are shown.

M Kosovich,
Midland, WA.

$20



REAR VIEW OF 44 WAY CARD EDGE CONNECTOR



on pin 2 of IC2, the 2kHz tone must be transmitted for at least five seconds to activate the relay. This long time constant provides protection against false triggering.

When setting up, adjust R1 first to eliminate breakthrough on strong signals, then adjust R3 for maximum sensitivity.

A. Nguyen,
Woodville Sth, SA.

$15

Editor's note: a 2kHz encoder is required for use with the above circuit. A 555 timer IC wired in astable mode and driving a miniature loudspeaker should do the trick. Readers are also advised that a complete tone encoder/decoder project for amateurs and CBers will be published in the near future.

Check your ICs on this simple

Op Amp Tester

Op amps are inscrutable little beasties, aren't they? Before you solder them into circuit it would be nice to be able to test that they are OK, wouldn't it? Our new Op Amp Tester allows you to check the main DC parameters of most common op amps. It is a low cost jig, intended for use with a digital multimeter.

by JOHN CLARKE & LEO SIMPSON

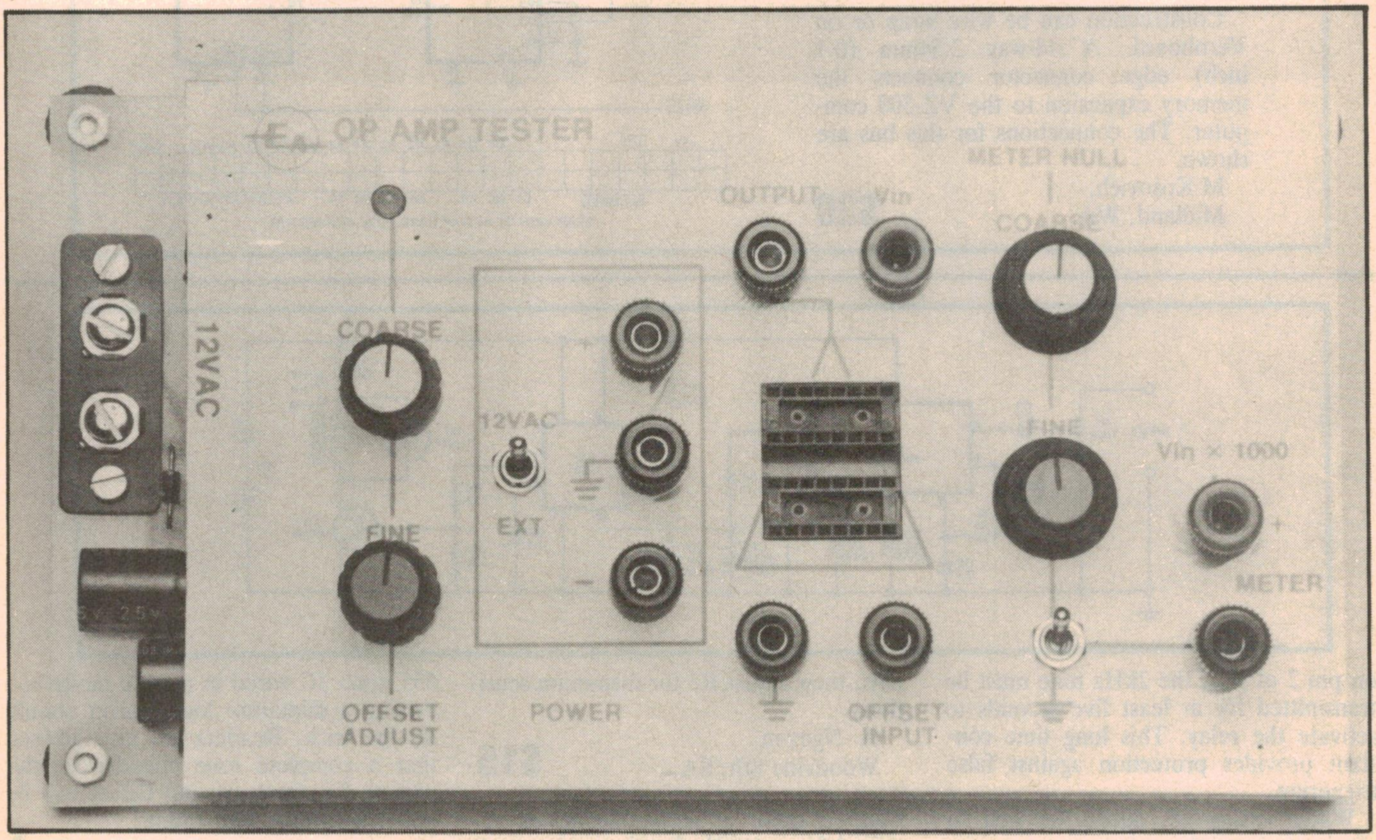
Operational amplifiers are very common circuit components used in the majority of today's analog circuits. As well as being used as DC and AC amplifiers, they also have applications as Schmitt triggers, comparators, filters, buffers, gyrators, level shifters and oscillators.

When a circuit using an op amp does not operate correctly, it is often difficult to know whether the fault lies with the circuit or the op amp itself. For this reason, it is very handy to be able to check common op amps in a standard circuit configuration.

Our op amp tester enables a number of standard tests for DC parameters to be made. This is better than some past designs we have seen which connect the op amp to work as an oscillator. Such a circuit can be regarded as providing a simple go/no go test but it may not detect some subtle problems with the op amp.

Besides testing several DC operating conditions, our Op Amp Tester can test quad, dual and single op amp packages. When more than one op amp is in a package, each op amp is tested separately.

Essentially, our Op Amp Tester is a do-all jig. It allows you to plug in any in-line or circular op amp package and then wire up positive and negative supply connections, the two inputs and the



The Op Amp Tester is a simple jig that lets you wire up and test just about any op amp.

TYPE	MAXIMUM SUPPLY VOLTAGE (V)	INPUT OFFSET VOLTAGE (mV)		INPUT OFFSET CURRENT (A)		INPUT BIAS CURRENT (A)		INPUT RESISTANCE (ohm)		LARGE SIGNAL VOLTAGE GAIN V/mV		COMMON MODE REJECTION RATIO (dB)		POWER SUPPLY REJECTION RATIO (uV/V)		SUPPLY CURRENT (PER AMPLIFIER) (mA)	
		typ	max	typ	max	typ	max	min	typ	min	typ	min	typ	typ	max	typ	max
NE5534	44	0.5	4	20n	300n	500n	1.5μ	30k	100k	25	100	70	100	10	100	4	8
741C, 747C	36	2	6	20n	200n	80n	500n	0.3M	2M	20	200	70	90	10	150	1.7	2.8
TL071, TL072 TL074	36	3	10	5p	50p	30p	200p		1T	50	200	70	76	150	300	1.4	2.5
LF351, LF353 LF347	36	5	10	25p	100p	50p	200p		1T	25	100	70	100	10	300	1.8	3.4
CA3140	36	5	15	0.5p	30p	10p	50p		1T	20	100	70	90	100	150	4	6
LM324	32	2	7	5n	30n	45n	250n		—	25	100	65	70	10	300	1.5	3
TL061, TL062 TL064	36	3	15	5p	200p	30p	400p		1T	3	6	70	76	10	300	200μ	250μ
CA3130	16	8	15	0.5p	30p	5p	50p		1.5T	50	320	70	90	3	20	2	3

Fig.1: typical performance specifications for a range of common op amps. The tester can check most of these specifications.

output. The Tester contains circuitry to null out the offset voltage of the op amp under test, and to vary its DC input voltage. In addition, there is a high gain DC amplifier to enable any typical multimeter to measure the very low voltages which are a feature of any normally operating op amp.

Very simple construction is used for the Tester. It is basically a free-standing printed circuit board which has a screen-printed (or Scotchcal label) Perspex panel over it to accommodate the various controls, switches and terminals.

Seven parameters can be tested: Input Offset Voltage, Input Offset Current, Input Bias Current, Input Resistance, Large Signal Voltage Gain, Power Supply Rejection Ratio, and Op Amp Supply Current. These parameters should quickly reveal a faulty op amp if the measured results differ from specifications.

These major DC specifications are important when designing circuits since they indicate how the op amp is likely to perform in a particular circuit configuration. The type of op amp chosen depends on how suitable its characteristics are for the application concerned and also as a compromise against cost.

Fig.1 lists the specifications for some commonly used op amps. These are parameters characterised at 25°C and with a ±15V power supply. The exception is the CA3130 which is specified using a single 15V supply rail. Specifications are given for minimum, typical and maximum results expected from the particular op amp.

Where the magnitude of the parameters is very small, the multiplier for the unit is shown after the specification value. For example, the Input Offset Current is specified in amps, while the actual values can be microamps, nanoamps or picoamps. Note that μA refers to 10^{-6}A, nA refers to 10^{-9}A while pA is 10^{-12}A.

Similarly, where the parameters are very large, such as the input resistance of op amps, the unit values can be kilohms, megohms or teraohms. The tera multiplier is 10^{12}. For more detailed information on each op amp, refer to the manufacturers' data books.

Circuitry

As noted above, the Tester is a jig which provides positive and negative power supplies, connections for the two op amp inputs and its output, provision to vary the input voltages, and a high gain amplifier.

Power supply for the Tester can come from either a mains AC plugpack or external DC power supply with balanced rails. We have made provision for both possibilities. If a 12VAC plugpack is used, it is connected to the 12VAC input terminals on the board. The AC is rectified via D1 and D2 and filtered with 470μF capacitors which then feed 3-terminal regulators to provide ±12V supplies.

The alternative is to use an external regulated power supply which will normally be set to provide the standard ±15V rails for most op amps. In this case, S1 is set to the external position to isolate the outputs of the 12V regulators.

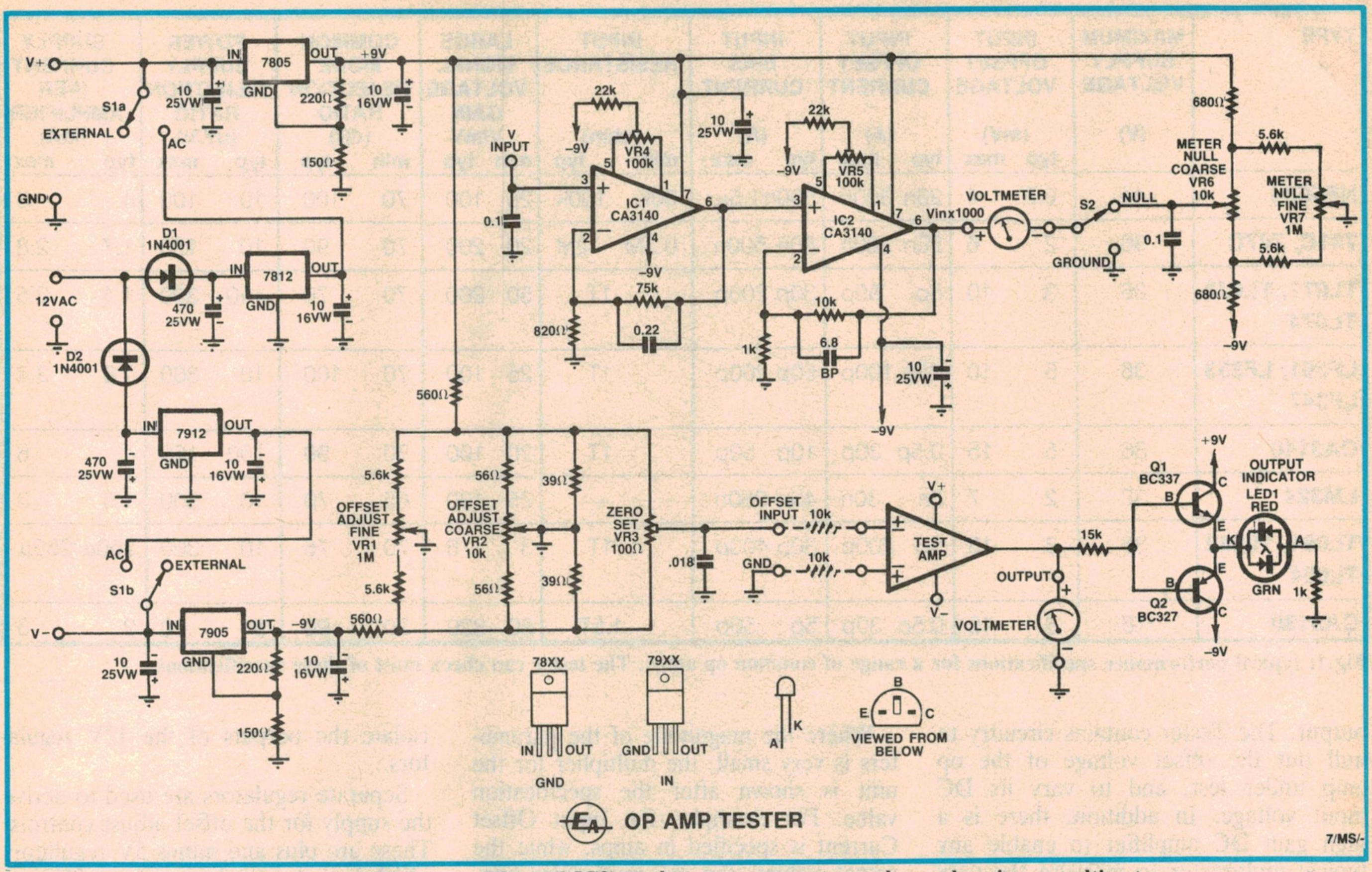
Separate regulators are used to derive the supply for the offset adjust controls. These are plus and minus 5V regulators which have been adjusted for a 9V output using a 220Ω resistor between the output and common, and a 150Ω resistor between the common and ground. They also supply op amps IC1 and IC2, and the meter null circuitry.

To provide a suitable offset voltage adjustment, we have used 1MΩ potentiometer VR1 for very fine voltage adjustment, 10kΩ potentiometer VR2 for coarse adjustment, and 100Ω trimpot VR3 for initially setting the output to zero. Operation of the fine and coarse controls is not linear and so the range of adjustment is limited using 5.6kΩ and 56Ω resistors in series with the fine and coarse controls respectively.

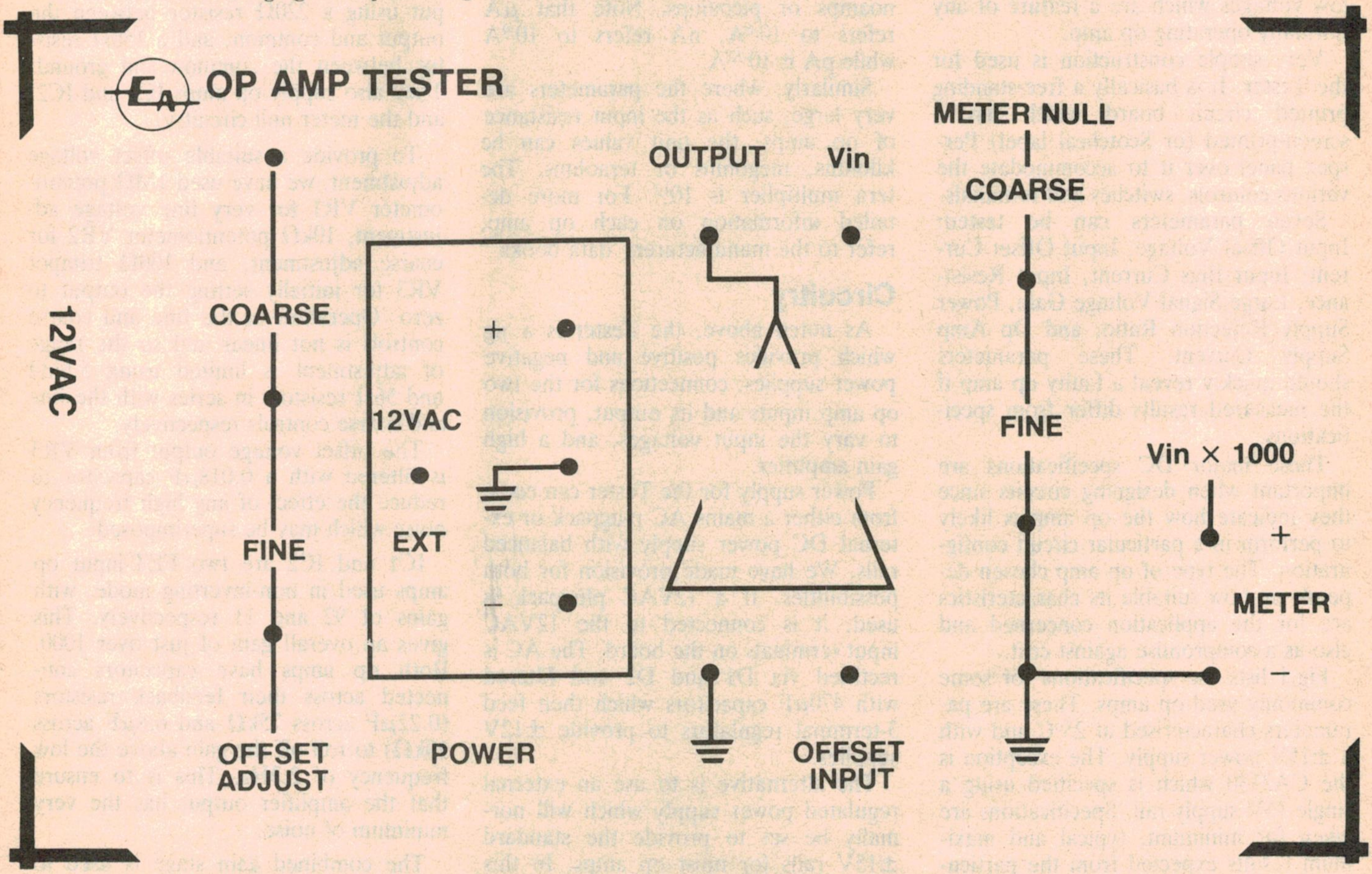
The offset voltage output from VR3 is filtered with a 0.018μF capacitor to reduce the effect of any high frequency noise which may be superimposed.

IC1 and IC2 are two FET-input op amps used in non-inverting mode, with gains of 92 and 11 respectively. This gives an overall gain of just over 1000. Both op amps have capacitors connected across their feedback resistors (0.22μF across 75kΩ and 6.8μF across 10kΩ) to roll off the gain above the low frequency of 2.3Hz. This is to ensure that the amplifier output has the very minimum of noise.

The combined gain stage is used to monitor voltages at the input of the test



The circuit includes a high gain amplifier stage (IC1 and IC2) so that measurements can be made using a multimeter.



Here is an actual size reproduction of the front panel artwork.

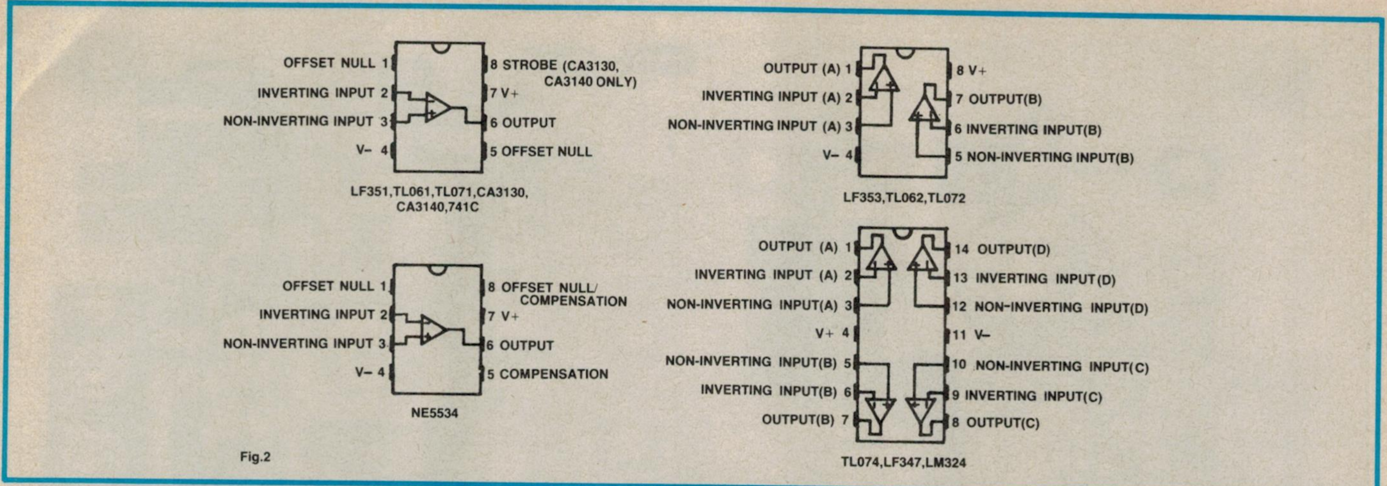


Fig.2: these diagrams show the pin connections for all the op amp types listed in Fig.1.

op amp and thus enable any multimeter to be used for testing. The input (pin 3) of IC1 has a very high input resistance which is typically around 1.5 teraohms, and a very low input current of typically 10pA.

So as well as providing a gain of 1000, the op amp stages in the Tester provide an absolute minimum of loading during any voltage measurements. This in turn ensures maximum accuracy.

VR4 and VR5 are for offset adjustment to set the output of IC1 and IC2 to zero.

Switch S2 selects whether the meter is referenced to ground in position 2 or referenced to the meter null output in position 1. This facility can be used when measuring the DC gain and input offsets of the op amp under test. VR6 is the coarse control for the meter null and VR7 is the fine control.

Q1 and Q2, in conjunction with a dual colour LED, provide a coarse indication of the output voltage of the op amp under test. When the output of the test op amp is high, Q1 switches on and turns on the green portion of the indicator LED. For the opposite condition — ie, when the output of the test op amp is low — Q2 switches on and drives the red portion of the LED. The 15kΩ resistor provides base current limiting for Q1 and Q2 while the 1kΩ resistor provides current limiting for the LED.

Finally, if the output of the op amp under test is less than ±0.6V, the LED will be off. This is because this level of voltage is insufficient to turn on either Q1 or Q2.

Construction

All the parts are installed on a single PCB which is coded 87oa3 and measures 201 x 112mm. As mentioned above, a Perspex lid covered with a Scotchcal label (180 x 112mm) is used for the front panel.

Assembly is a straightforward process. If you do not intend to use a plugpack AC supply those components associated with the 12VAC input can be omitted. These include D1, D2, the 7812 and 7912 regulators, switch S1, the two-way screw connector and the four associated capacitors.

Install the resistors, diodes, ICs and wire links first. Note that the diodes and ICs must be inserted with the correct orientation as shown on the overlay diagram. The three terminal regulators are each mounted flat against the PCB and their leads bent so that the hole in the metal tab lines up with the appropriate hole in the PCB. Once the regulators have been soldered into place, they should be secured with a screw and nut.

Note: low power versions of the regulators, such as 78L05, may be used.

Now for the capacitors. These must be mounted side-on to provide clearance for the top panel (see wiring diagram). Make sure that the electrolytic capacitors are installed correctly.

The transistors and trimpots can be installed next. This done, mount the LED so that the top of the lens is 18mm above the PCB.

To wire in the pots, firstly solder short lengths of 20 gauge (or thereabouts) tinned copper wire into the holes for the pot connections. Before soldering the pot lugs to the wires, the shafts should be cut to a length to suit the knobs to be used.

Next, install the two switches and 12VAC connector in place. The two wire wrap sockets are each inserted so that the top is 16mm above the PCB. Do not install any of the binding post terminals at this stage. This step comes later.

Four rubber feet are fitted to the PCB, one at each corner. This raises the board and prevents the wiring beneath the PCB scratching the bench or table surface on which it is operated. Alternatively, you could mount the board on a suitable piece of timber, to make it easier to handle.

The Perspex panel for the Tester is 180 x 112mm and a plastic Scotchcal label covers this. As an alternative, kitsets will probably have screen printed panels. Incidentally, a metal panel should not be used since this would short out all the terminals.

If you are have a plastic Scotchcal label, it can be used as a guide to cutting out the holes in the Perspex sheet. Cut the holes very slowly and with a solid support beneath the Perspex since this material is very brittle.

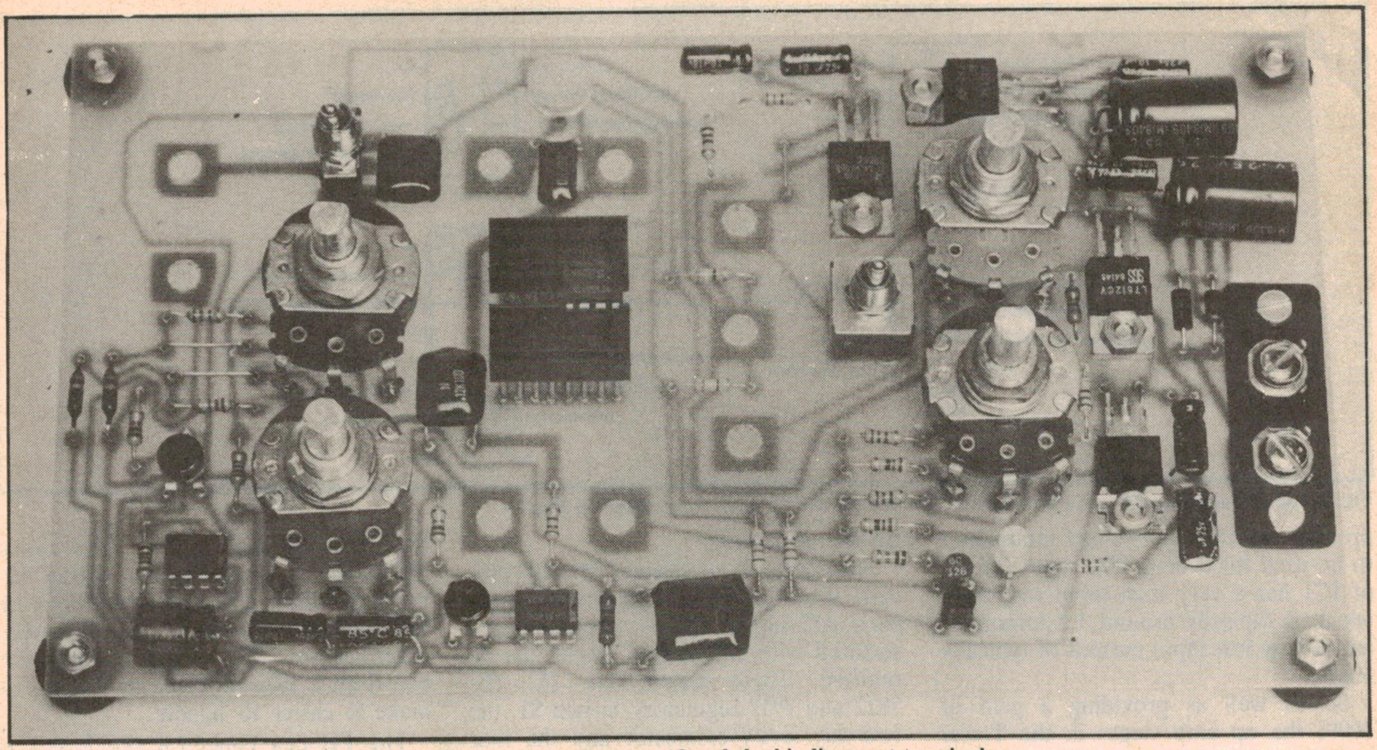
A rectangular cutout is required for the two sockets which hold the op amp under test. To cut this, drill many small holes around the perimeter and gently break out the rectangular piece. The hole can then be filed to a smooth rectangular shape.

The next step is to test the unit. During this process, all the trimpots are adjusted. Once the panel is on, the trimpots cannot be adjusted.

Connect power to the Tester, via AC plugpack or external balanced supply, and switch S1 to 12VAC or EXT as appropriate. To make connections to the board, it is best to temporarily solder short lengths of tinned copper wire to the various copper pads in place of the binding posts. Connections can then easily be made with alligator clips.

It is probably also a good idea to temporarily label each terminal on the board, with pencil, to lessen the possibility of making incorrect connections.

Apply power and check the voltages at the inputs and outputs of the regulators. The output of each regulator



The completed PCB assembly, prior to installation of the front panel and the binding post terminals.

should be within 10% of the specified voltage. Check for +9V at pin 7 of IC1 and IC2, and for –9V at pin 4 of both ICs.

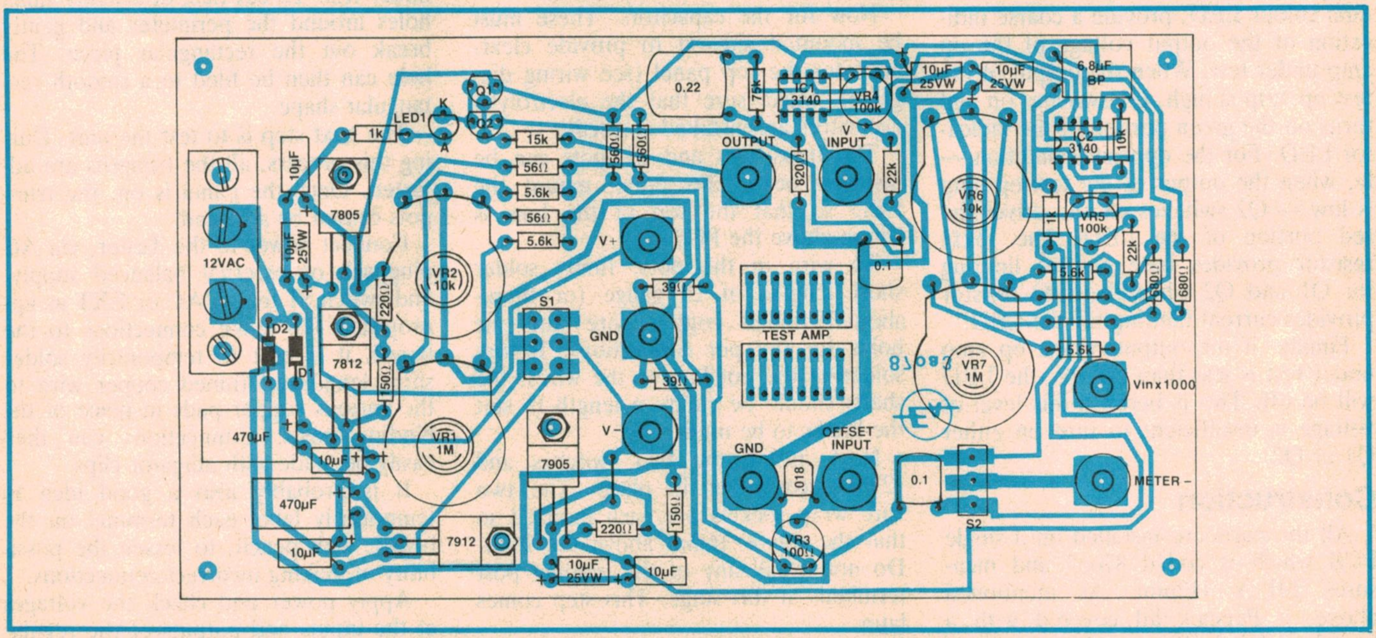
Now the Offset Adjust control can be checked. Connect a multimeter between the Offset Input and Ground, centre the coarse and fine controls, and adjust the zero set trimmer for a 0V reading. Adjustment of the coarse control should give a ±70mV range, while the fine control should give a ±1mV range.

The meter null output is checked by connecting a multimeter between the meter (-) terminal and a ground terminal with S2 switched upwards towards the meter null controls. The coarse control should give a ±7.7V range and the fine control a ± 0.4V range.

Testing of the LED output indicator is simply done by connecting the "output" terminal to the positive ("+") supply terminal. The LED should be green. Connecting the "output" terminal to the negative power terminal should then cause the red portion of the LED to light.

VR4 and VR5 are for adjusting the output of IC1 and IC2 to zero with the Vin input connected to ground (earth terminal on panel). First, connect a multimeter between pin 6 of IC1 and ground and adjust VR4 for a reading as close to zero as possible. Next connect the meter between ground and the Vin x 1000 output and adjust VR5 for a reading as close to zero as possible.

Once testing has been completed, remove the tinned copper leads from the



The capacitors and 3-terminal regulators must be laid flat against the PCB as shown in this wiring diagram.

PARTS LIST

1 PCB, code 87oa3, 201 x 112mm
1 Scotchcal front panel, 180 x 112mm
1 Perspex front panel, 180 x 112mm
9 4mm binding posts
1 2-way screw terminal strip
1 DPDT miniature toggle switch
1 SPDT miniature toggle switch
4 rubber feet
4 knobs
9 9mm spacers for binding posts (see text)
2 16-pin wire wrap sockets
1 12VAC plugpack (optional)

Semiconductors

2 CA3140 MOSFET input op amps
1 7812, 78L12 3-terminal regulator
1 7805, 78L05 3-terminal regulator
1 7912, 79L12 3-terminal regulator
1 7905, 79L05 3-terminal regulator
1 BC338 NPN transistor
1 BC328 PNP transistor
2 1N4001 diodes
1 bicolour LED

Capacitors

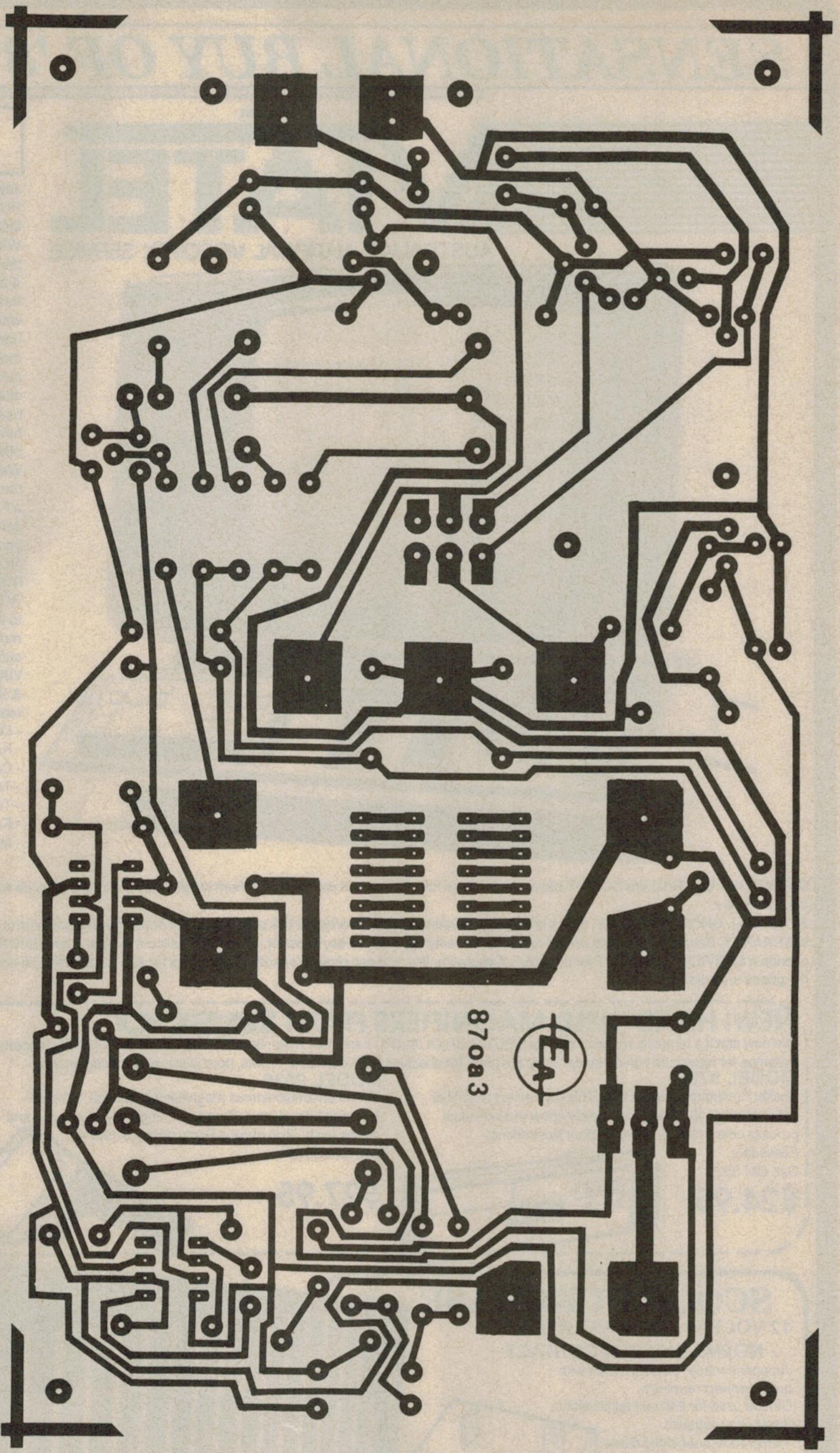
2 470μF 25VW PC electrolytic
4 10μF 25VW PC electrolytic
4 10μF 16VW PC electrolytic
1 6.8μF bipolar electrolytic
1 0.22μF metallised polyester
2 0.1μF metallised polyester
1 0.018μF metallised polyester

Resistors (0.25W, 5% unless noted)

1 x 75kΩ 2%, 2 x 22kΩ, 1 x 15kΩ, 1 x 10kΩ, 4 x 5.6kΩ, 2 x 1kΩ, 1 x 820Ω, 2 x 680Ω, 2 x 560Ω, 2 x 220Ω, 2 x 150Ω, 2 x 56Ω, 2 x 39Ω, 2 x 100kΩ miniature horizontal trimpots, 1 x 100Ω miniature horizontal trimpot, 2 x 1MΩ linear potentiometers, 2 x 10kΩ linear potentiometers

Miscellaneous

Screws, nuts, washers, solder etc.



This is the actual size artwork for the printed circuit board.

binding post positions.

The front panel can now be fitted over the switches and pots. The first job is to affix the Scotchcal label to the Perspex panel. This done, use a sharp knife to cut the holes in the artwork to match those in the Perspex panel.

The front panel is supported 13mm above the PCB using a 9mm spacer, two washers and a nut for each binding post terminal; a nut or four washers for the pots; and a nut for the switches. Additional nuts are then used to secure the pots and switches to the front panel, and the binding posts to the underside of the PCB.

Finally, install the knobs and the tester is complete. Next month we will detail each of the tests which can be made on the Tester and show how typical op amps are connected.

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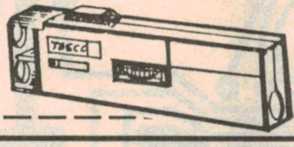

MODEL 9536

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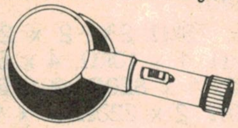

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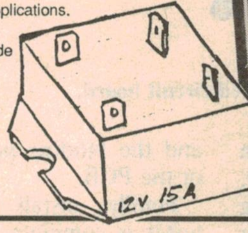

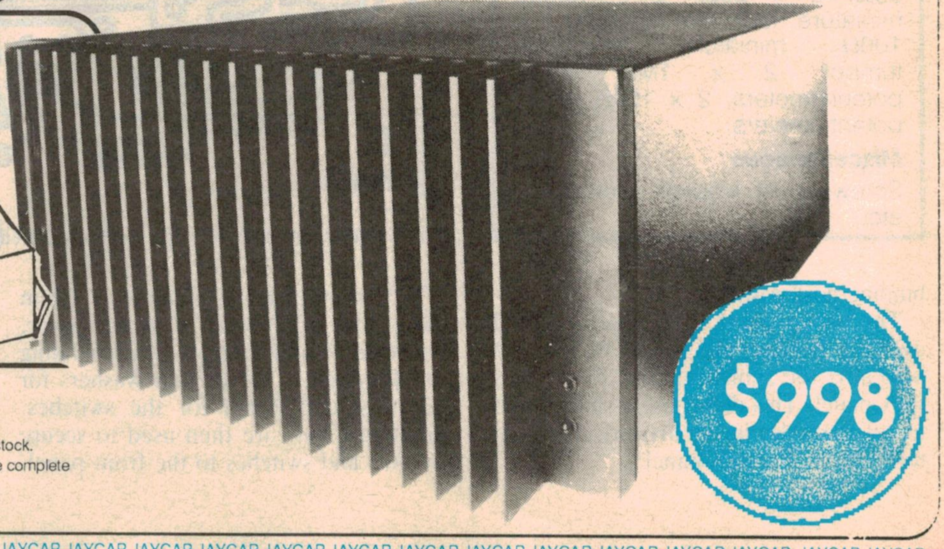

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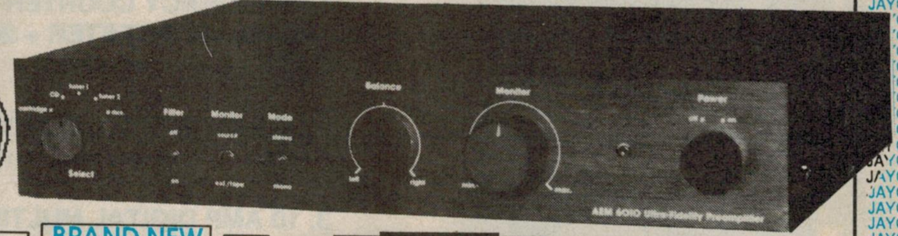
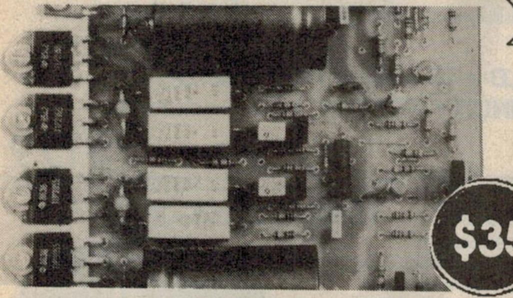


AEM 6505 WORK HORSE AMP MODULE



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Ref: AEM January 1987

A genuine low cost power amp "slave" module. Keeps costs down by having power supply filter caps on board. All that is required to make module operational is ±30 - 40V (DC unfiltered), a signal source and a load. Works well with PA line transformers too. All board parts supplied including jig drilled heatsink bracket.

Cat. KM-3050

BRAND NEW KIT

AEM RTTY ENCODER

Companion for 'Listening Post'

Ref: AEM May/June 1987

Here's the low-cost way to get on the air with radioteletype (RTTY). This encoder teams up with the ever popular AEM 3500 Listening Post kit (Cat. KM-3015 $39.95) to make a complete transmit/receive tone decoder/encoder. Join the ranks of the thousands of amateurs around the world using the fascinating RTTY mode! Designed to connect in line between your AEM3500 Listening Post and your computer. The Jaycar kit comes complete with with case, Scotchcal front panel and connection hardware for "Listening Post". See AEM for software info.

Cat. KM-3016

$59.95

BRAND NEW KIT

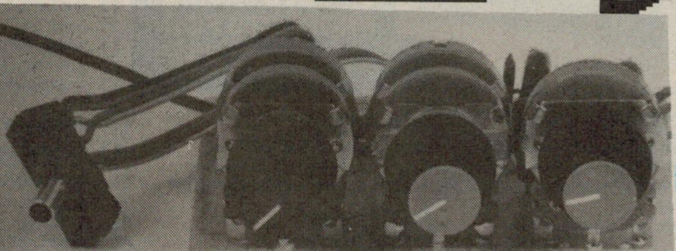
BATTERY VOLTAGE METER

- Ref: EA May 1987

This simple project connects directly to the battery in your car. It will indicate under-normal - or overcharging via a bar display of yellow green and red rectangular LEDs. Can be mounted on dash of car. All specified board components supplied.

Cat. KA-1684

$14.75



$23.50

ETI 1406 PARAMETRIC EQUALISER MODULE

Ref: ETI August 1986

Module can be used on its own or ganaged to equalise a whole system. Parametric equalisers tune around a centre frequency reducing the number of units required in a signal line (reducing distortion) over the more normal "grahic" equalisers.

The Jaycar kit is supplied with all board components including pots, knobs, switch and TL071 IC.

SEE THE 1987 JAYCAR CATALOGUE FOR SPECIFICATIONS

Cat. KE-4724

ETI467 MIXER PREAMP

Ref: ETI July 1980

$39.50

PLAYMASTER 60-60 AMPLIFIER - BLUEPRINT VERSION

The interest in the Playmaster 60-60 has been absolutely tremendous. We have not had such interest in a kit since the 5000 amp was released! When we released the 'Black Monolith' 5000 series amp it was extremely popular. People appreciated the quality refinements to the kit.

Well we now have a 'Blue printed' version of the Playmaster 60-60. We believe what is shown below represents a significant improvement in the development of this project.

★ Dual diagonally wound C-core power transformer. Endorsed in writing (with each kit) by EA. Slightly higher power rating than toroid power transformer (which is in the standard kit).

★ For lower noise, metal film 1% 50ppm resistors are now supplied where 5% carbon types were originally specified.

★ Power supply filter capacitors - Doubled! That's right, the Blueprint amp has 4 x 4700uF/63V filter capacitors instead of the 4 x 2200uF types in the standard version. This is a significant improvement in power supply performance!

★ Special extruded heatsink. The heatsink section is machined from a heavy section extruded aluminium section. It is then black anodised. The standard heatsink is folded sheetmetal not anodised.

★ Special high quality pretinned PCB

★ Special front panel graphics emphasising the Blueprint treatment to the amp.

We feel that this is a tremendous development in kit amp construction, especially when you consider the modest price!

The standard 60-60 kit Cat. KA-1650 is still available for $299. But the new Blueprint amp is an absolute bargain at only $349! That's right, you can have the Blueprinted version of the kit for only a little more!

When the 5000 'Black Monolith' blueprinted amp came out we could not keep up with demand. Customers were happy to wait up to 6 months! We do not expect this to be the case with the 60-60 but if you are contemplating the purchase of one of these fine kits (there is nothing wrong with our standard kit, by the way) we suggest that you buy soon!!

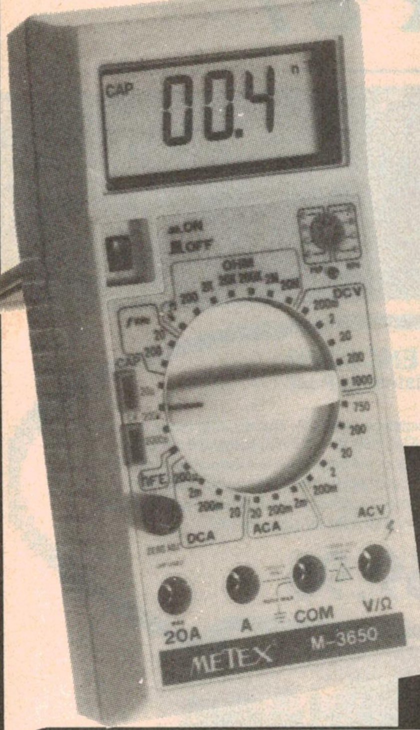
Cat. KA-1652

BLUEPRINT 60-60

A JAYCAR SCOOP PRODUCT

Illustration shows standard 60-60 panel livery. Special livery only on the Blueprint version.

$349



DIGITAL MULTIMETERS

See our 1987 Catalogue for full specifications

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2. 10 AMP DIGITAL MULTIMETER WITH TRANSISTOR TEST FACILITY - (Not illustrated) Cat. QM-1530 **$89.95**

3. 10 AMP DIGITAL MULTIMETER + TRANSISTOR TESTER + CAPACITANCE METER - (Not illustrated) Cat. QM-1540 **$129**

4. 4.5 DIGIT + DIGITAL HOLD + 10 AMP + TRANSISTOR TESTER + AUDIBLE CONTINUITY TESTER (Not illustrated) Cat. QM-1550

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This device mounts near the rear of any 12V vehicle. When +12V is connected (i.e. from reverse gear switch) it will give that familiar "beep-beep" noise. Simple panel mount fixing. (Operates 4-28V)
69dBA min - 80dBA max.
Cat. AB-3442
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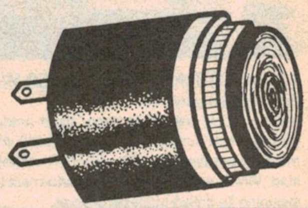

FIBRE OPTIC EVALUATION KIT

The EDU-LINK kit is a fibre optic evaulation system consisting of TTL compatible transmitter board IR LED, 1 metre of fibre optic cable, photodiode and TTL compatible receiver board. The fibre optic connectors are also included. Manual includes instructions, theory and tutorial.
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These beautifully crafted rack cabinets will give your equipment a real 1st class appearance. All aluminium construction. Removable top and bottom panels. Natural or black finish. All dimensions conform to the International standard. Ventilated lid. Deluxe brush finish anodised front panel. Individually cartoned. Supplied in flat pack form and easily assembled in a few minutes.
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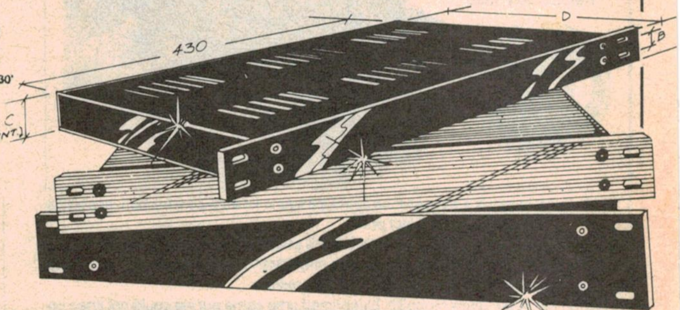
Cat. HB-5413	Natural	88	57	82	$75.00	$71.00
Cat. HB-5415	Natural	132	89	126	$85.00	$80.00
Cat. HB-5410	Black	44	34	38	$65.00	$62.00
Cat. HB-5412	Black	88	57	82	$75.00	$71.00
Cat. HB-5414	Black	132	89	126	$85.00	$80.00

Beware of other rack cabinets that do not conform to International Rack sizing.



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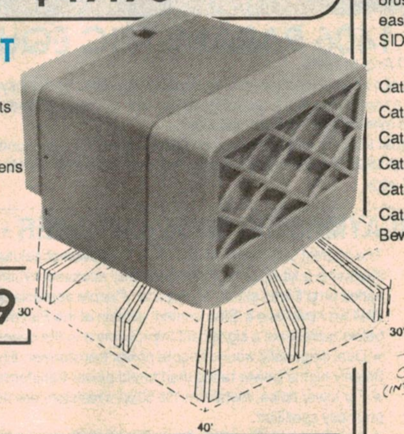
The ideal unit to add to an alarm system. IR units such as this unit do not respond to non-heat radiating objects - even the cat is unlikely to trip this unit. When a human being passes the lens the unit will selectively pick up IR radiation and then not. A series of pulses are then sent to a detector unit.
FEATURES:
12V DC powered
Double sensor
Computerised OC to lower failure rate
Built-in test lamp
Alarm output SPST 30V DC @ 1 amp
Cat. LA-5017

$109



DPM500 3.5 DIGIT DISPLAY

This meter is compatible with the popular 7106, 26 & 36 range of A/D convertors and as a single component can replace cumbersome LCD, A/D and numerous discrete components in existing applications. Auto zero, auto polarity, 200mV FSD, 12.5mm (0.5") digit height and programmable decimal points are standard. There are many engineering symbols and an output for auto ranging use.
Full specs in the 1987 Jaycar Catalogue.
Cat. QP-5504 **$75.00**

AVTEK MEGA-MODEM

Brand new 'smart' modem from an Aussie leader. Has full auto recognition of outgoing and incoming calls. Permanently connected to your phone and computer. High speed 1200/1200 (V22), Bell 212 option is available that can be fitted internally.
300/300, 1200/75, V21/V23
Cat. XC-4832
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V21/V22/V23 (1200/1200)
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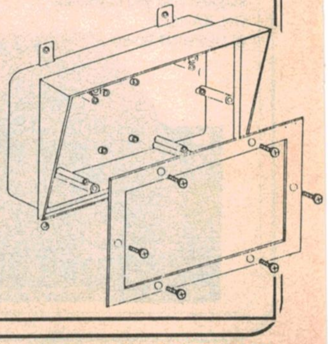
$699.00
Full specifications in the Jaycar 1987 Catalogue - available for $1 from all stores or via mail (included large SAE)

WEATHERPROOF OUTDOOR PLASTIC ENCLOSURE

This enclosure is moulded in black UV stabilised ABS plastic. The front cover is moulded in clear polycarbonate. A rubber gasket is supplied along with nylon cover fixing screws.
It is ideal for mounting an electronic assembly in the open. Because the cover is clear, circuitry inside can be operated by remote infra red control.
It is also ideal for a weatherproof LED or liquid crystal displays.
This is a high quality cabinet. Ideal for electric fences.
Cat. AB-6060
$29.95



JAYCAR JAYCAR

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Cat. YT-7065

DON'T PAY $295

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Frigi-Fresh automatically circulates the air inside a refrigerator after each door opening. Air is drawn thru the inlet grille (shown). It passes through a special filter that absorbs odours. The Frigi-Fresh automatically turns itself off approx 12 seconds after the door is closed.
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Spare filters Cat. YF-5523 $3.00 each
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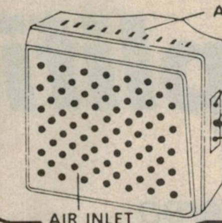

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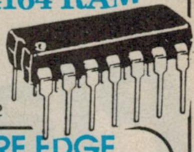

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POLYSWITCHES

Ref: EA July 1986

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RN3410 is suitable for protection of tweeters in systems up to 100 watts. It's rated at 50V & 0.5A. Nominal resistance is 0.4 ohms.
Cat. RN-3410
RN3415 will protect midrange and woofers up to 100 watts. Rated at 50V & 1.15A. Nominal resistance is 0.12 ohms.

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$6.98 ea
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This one is $15.50 cheaper than last year!
It will control mice, rats, roaches, crickets, silverfish, waterbugs, moths, etc.
Size: 100 x 90 x 80mm.
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Cat. QM-6135

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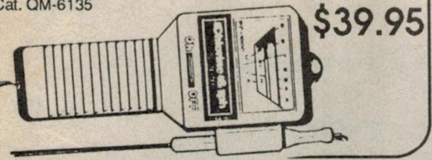

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UNIVERSAL NiCad CHARGER

Features:
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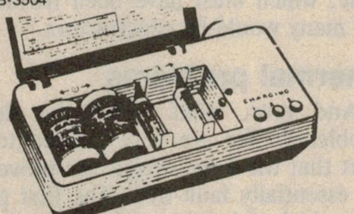

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This handy charger will recharge your Gel batteries. Delivers 300mA current at 12 volts DC. Supplied with quick connect lugs for easy connection to the battery.
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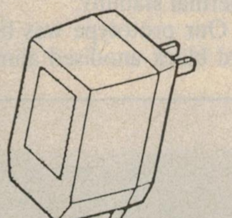

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Ideal for alarms or anywhere where constant use depletes batteries quickly.
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* Charges button cells
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Cat. MB-3502

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Jaycar ELECTRONICS

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JAYCAR JAYCAR

Feedback on the Playmaster 60/60 stereo amplifier

Since the Playmaster Sixty-Sixty stereo amplifier was published in May, June and July last year, it has proved to a very popular project. However, it has not been without its teething problems in the marketplace. This article details some of those and gives some handy hints on troubleshooting.

by LEO SIMPSON

When we published the design of the Playmaster Sixty-Sixty last year, we were certain that we had produced a winner. And so it has proved to be but it has been nowhere a big as it would have been if it had been better promoted by the major kitset suppliers. Some of the bigger suppliers decided, for various reasons, not to kit up for the design and undoubtedly they have missed out on a lot of business in the meantime.

On the other hand, we at EA recognise that kitting up for such a large project is a major investment and that some companies were hard-pressed during 1986 which caused them to hesitate.

There have also been supply problems with some key components such as the imported toroidal power transformer, the low noise phono input transistors and the production of metalwork. These factors have conspired to render the kit virtually unavailable for months at a time, which must have been frustrating for many would-be constructors.

Thermal problems

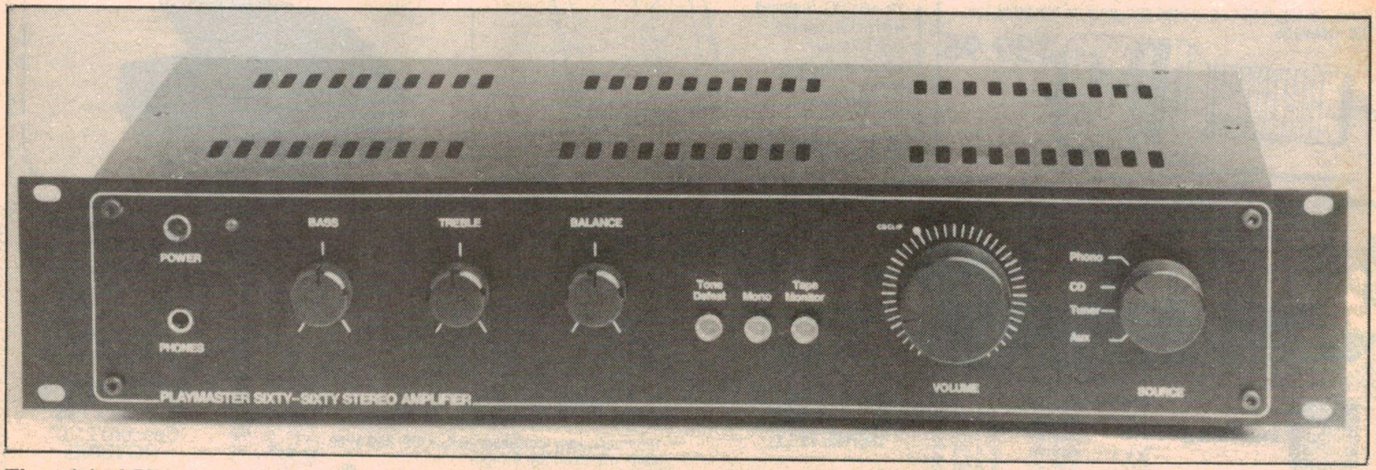
And now, what about the design problems? We are very pleased to report that the basic design has proved to be essentially fault-free. The first problem which did come to light was that of thermal stability.

Our prototype was built into a standard black anodised aluminium rack case but kit versions were made of steel. We were wary of the steel chassis at the outset and we checked the first example from a kitset supplier (Altronics) to make sure that it did not have any hum problems. Luckily it didn't but it wasn't until the constructors started putting the first kits together that the thermal stability problem arose. We had not reckoned on this at all.

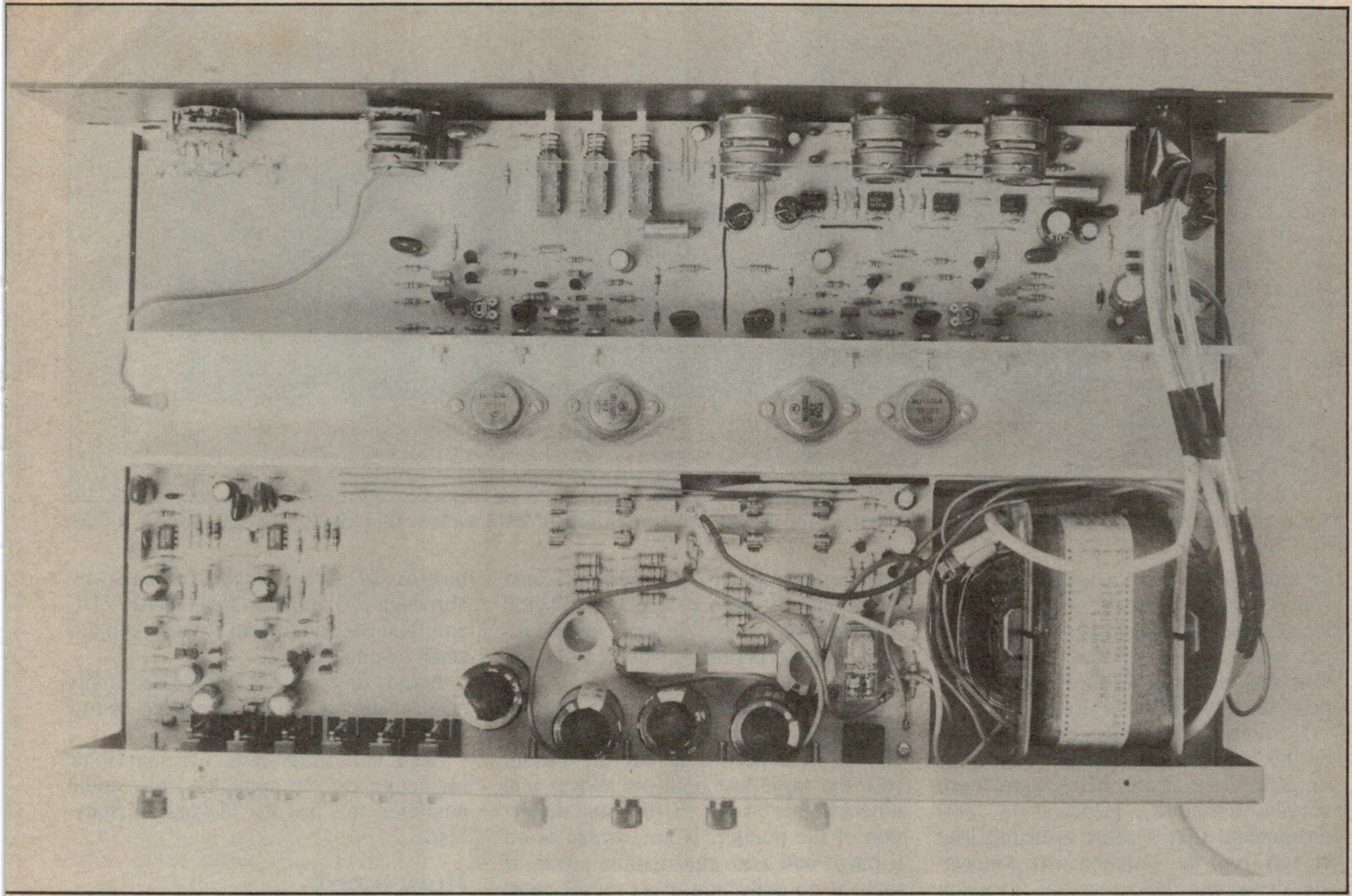
Constructors were finding that after setting the quiescent current as detailed in the instructions, the amplifier became very hot. The reason was that the quiescent current simply increased to the point where the output transistors were drawing more than an amp. If left turned on there was a great danger that the output transistors would continue to get hotter and hotter. It was a classic thermal runaway scenario.

It was caused by the combination of the steel chassis having less conductivity than that of our aluminium prototype and also having much less in the way of ventilation slots. With the less effective heat dissipation of the steel chassis, the quiescent current stabilisation provided by the specified BC547 transistors (Q12, Q112) was inadequate.

The solution, provided by a very



The original Playmaster 60/60 was built into an aluminium rack mounting case with generous ventilation slots.



This kit amplifier oscillated supersonically due to the use of wrong value compensation capacitors in the power amplifier stages. Note the addition of an earth lead between the body of the volume control pot and a solder lug on the heatsink (see text).

helpful reader who also alerted us to the problem, proved to be delightfully easy. It involved substitution of an MJE340 power transistor for the Vbe multiplier, Q12, in each channel (see Fig.1).

Each transistor is bolted to the heatsink using a mica washer for insulation. The mounting screw is fitted in the hole originally provided for clamping the BC547 to the heatsink. Heatsink compound should be smeared on the mounting surface of the transistor and the appropriate portion of the heatsink.

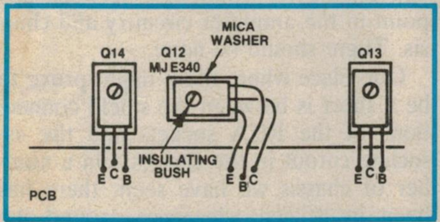


Fig.1: mounting details for the MJE340 Vbe multiplier transistor. The substitution of this transistor for the previously specified BC547 in each channel completely solves thermal runaway problems.

The base and collector leads of the MJE340 must be crossed over to suit the hole locations left by the original BC547.

At the same time, the bias network for Q12 (in each channel) must be altered by changing the 470Ω resistor between collector and base to 1kΩ. It is then a matter of setting the quiescent current to 20 milliamps in each channel, as detailed in the July 1986 issue, page 36. The above modification was published in Notes & Errata in the November 1986 issue.

Supersonic oscillation

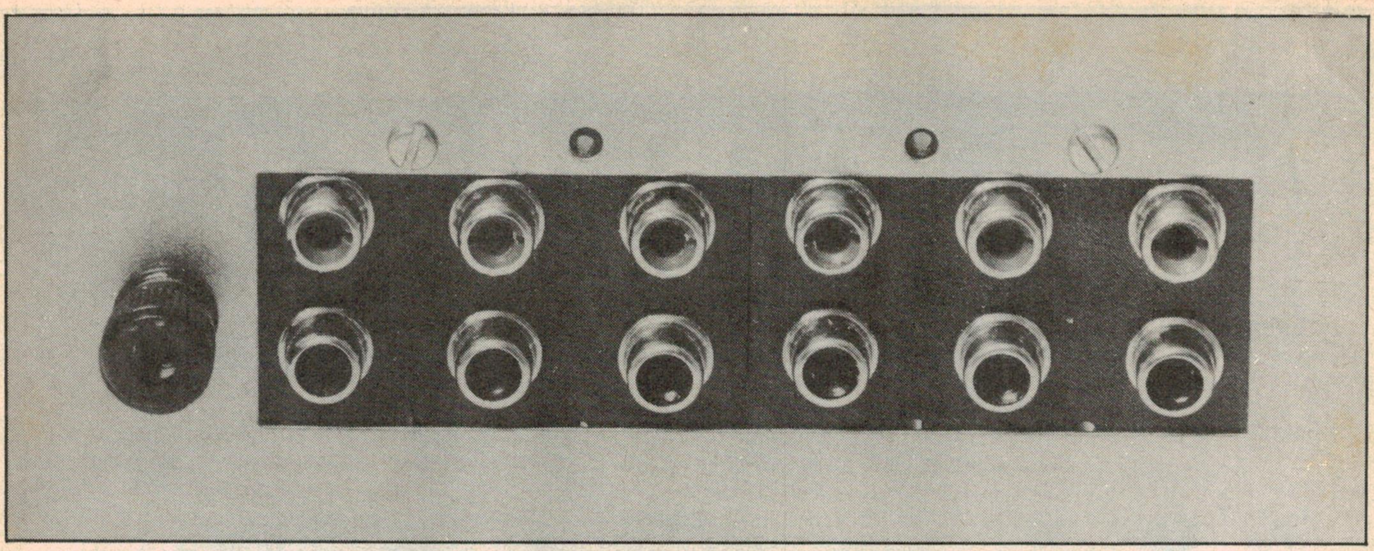
The second major problem, which has occurred only recently, also involved the amplifier becoming very hot. This time constructors found that they could not set the quiescent current at all.

On inspecting a kit amplifier which exhibited these symptoms, we found that it was oscillating supersonically. The reason was that the wrong value of high frequency compensation capacitor had been supplied in a few kits from Jaycar Electronics. Instead of the specified capacitor value of 68pF, the kits had 0.68pF supplied. The offending component is a very small ceramic capacitor from Philips, with body colours of red, purple and grey and labelled, very faintly, "p68".

This is an understandable mistake on the part of Jaycar. They have indicated that they will be happy to supply the correct capacitors to those who have purchased kits with the incorrect values.

Another possible cause of instability is an unearthed heatsink. Earthing the heatsink was not specifically mentioned in the original articles on the Playmaster Sixty-Sixty but is still essential. Earthing was accomplished by virtue of the metal pillars supporting the extrusion on either side. However, if plastic pillars are used, which has been the case in some kits, earthing does not occur. If you have a Playmaster Sixty-Sixty with plastic supports they should be replaced with metal pillars.

That brings us to another point. In the photos of the Playmaster amplifier (in May, June and July 1986) all the potentiometer cases have been con-



Some kit amplifiers have insufficient clearance between the chassis and the top row of RCA sockets. The result of a short here is a fairly loud hum.

nected together with a length of tinned copper wire soldered to each case. The idea behind this was to ensure that each pot was earthed via the front panel. This was also mentioned in the text on page 36 of the July 1986 issue.

However, establishing an earth path by this method is easier said than done since the front panels of kits have been heavily anodised. Hence, we now recommend that a short insulated lead be run from the common wire connecting all the pot cases together, to a solder lug on the heatsink. The accompanying photo shows the details.

Incidentally, if you do not have an oscilloscope and suspect that your amplifier is oscillating supersonically, because it is getting hot, there are a couple of easy tests. First of all, is the 6.8Ω 1W resistor in the output stabilisation network getting hot? This is a sure sign of trouble. Maybe it is charred which means that it has really been getting red in the face.

For a more direct test, you could use an oscilloscope, if you have access to one. Just place an input probe on the amplifier output, at the junction of the eight 1Ω emitter resistors, and look for the presence of a very high frequency signal on the screen.

We suggest the junction of the emitter resistors as the test point for the following reason. The output stabilisation filter has a high frequency rolloff above 20kHz which may severely attenuate any high frequency signal, which could give the impression that the amplifier is not oscillating.

If you don't have an oscilloscope, you can test for the presence of supersonic signals with your multimeter which for this test should preferably be an analog type with a good AC sensitivity and good high frequency response. Digital multimeters are not so good in this regard and the digital display can be misleading.

Switch your multimeter to a reasonably high AC voltage range, such as 10VAC. Connect it across the output (use the same test point as above) and note whether or not there is any deflection of the pointer. If not, switch down a range and note the reading again. If there is no deflection at all on the most sensitive range, then it is a fair bet that if the amplifier is getting hot, it is probably not due to supersonic oscillation.

Note that this test will not reveal all forms of supersonic oscillation — it takes an oscilloscope with a wide bandwidth to be really certain.

If you know that your multimeter has a poor high frequency response or is a digital type, it is possible to test for the presence of high frequency signals with the circuit of Fig.2. It is a half-wave voltage doubler rectifier with the capacitors suited for high frequency measurements. Germanium diodes are specified for maximum sensitivity. When using this test circuit, the multimeter should be switched to a reasonably high DC voltage range, say 10VDC and then switched down if the reading is small or non-existent.

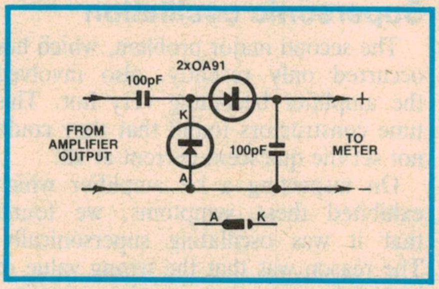


Fig.2: this half-wave voltage doubler circuit can be used with a digital multimeter to check for supersonic oscillation.

Again, this test has limited sensitivity and will not reveal the presence of low level instability.

Note that these tests for supersonic oscillation can be applied to any audio amplifier, not just the Playmaster Sixty-Sixty.

Hum loops

Hum loops can be a bugbear in any audio amplifier but provided the Playmaster Sixty-Sixty is built and wired according to the circuit and wiring diagrams there should be no problems in this regard. The amplifier has single point earthing. This means that the only point where the amplifier circuit board is connected to chassis is from the central node between the four 0.1μF capacitors via a wire to the earth lug near the transformer. If this wire is disconnected, there should be no other connection from amplifier circuitry to chassis.

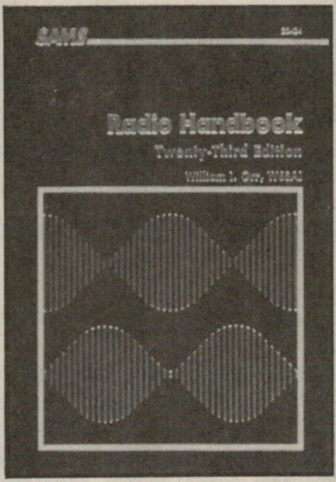
This can be confirmed by switching your multimeter to a low ohms range and testing for continuity between any point in the amplifier circuitry and chassis. There should be none.

One place where there might prove to be a short is between the shield connections of the RCA sockets and the associate cutout in the chassis. On a number of chassis we have seen, there has been insufficient clearance around the top row of RCA sockets. The result of a short here is a fairly loud hum. Fixing it is easy. Just remove the short by increasing the clearance around the sockets.

Books & Literature

For the amateur radio operator

RADIO HANDBOOK, by William I. Orr. 23rd edition published 1987 by Howard W. Sams & Co, Indianapolis, Indiana, USA. Hard covers, 195 x 255mm, 672 pages, illustrated with many photos and diagrams. ISBN 0 672 22424 0. Price $75.00.



William Orr's Radio Handbook is well known to amateur radio operators and is now in its 23rd edition. According to the publishers, it has been completely revised and contains new material in many of the chapters. Having not seen recent editions, we are unable to comment on the degree of revision but we would regard it as a worthy addition to the bookshelf of any amateur or professional radio operator.

For those not familiar with this reference, it contains 28 chapters on a whole range of topics relevant to amateur radio operation and these are all treated in great detail. Some of the more comprehensive chapters include those on amplifying devices, communications receiver fundamentals, generation and amplification of RF energy, HF amplifier construction, VHF amplifier construction, radiation and propagation, transmission lines and matching systems, test equipment and power supplies.

As you might expect, the text includes the circuits and constructional details of many pieces of amateur equipment, from low noise GaAs FET preamplifiers, to yagi antennas.

One point should be made. For those looking for a comprehensive reference book on the subject of amateur radio, this text should not be regarded as an alternative to the ARRL Handbook. Rather, it is a good complement to it. For the well-read amateur then, this text is highly desirable. (L.D.S.)

Television interference handbook

RADIO FREQUENCY INTERFERENCE HANDBOOK, produced by the Department of Communications, Canberra. Published 1986 by the Australian Government Publishing Service. Stiff paper covers, 177 x 249mm, 92 pages, illustrated with 34 colour photos and many circuit diagrams. ISBN 0 644 03587 0. Price $9.95.

For too long, there has been a dearth of information specific to Australia about the sources of radio and television interference and the methods of cure. For some time though, the Department of Communications has been providing a sterling service via its hard-pressed radio inspectors and engineers in each state and these people have developed a lot of skill in this field.

Now, the DOC has produced a distillation of the information it has gathered and published it in this handbook. And a very fine job it is, too.

While the title of the book alludes to radio interference, the main subject is television interference in its many forms. Specific examples are given of interference from the following sources: thermostats, fluorescent lamps, fluorescent starters, sodium vapor and gas discharge lamps, universal motors, simmerstat, electric razors, masthead amplifiers, photoelectric controlled street lights, lamp dimmers, digital clocks, incandescent lamps, TV line oscillators and local oscillators, switchmode power supplies, diathermy machines, RF heating, CB radios, FM radio broadcasts, pilot arc welders, ultrasonic alarms, power lines, and adjacent channel and co-channel TV.

Most of these examples are described in detail, together with the methods of cure, and are accompanied by colour TV pictures which make identification of such interference a simple matter. The illustrations are excellent.

There is also a good chapter on television propagation and a brief explanation of how ghosting occurs. The method of determining the path of the ghost reflected signal is given, together with suggestions for mitigating the effects of multipath reception. As well, there is a chapter on interference to audio equipment with suggested cures.

Essentially, the book was written for the use of DOC field staff but could be most useful to television and audio technicians, amateur radio operators, and to anyone interested in eliminating radio and TV interference. In short, it's an excellent reference and is available from AGPS (Australian Government Printing Office) bookshops or by mail order for $9.95 including postage and packing. Our review copy came from the DOC. (L.D.S.).

(Note: a good complementary text on this subject is Interference Handbook by William Nelson, published 1981 by Radio Publications, USA. ISBN 0 933616 01 5. It was reviewed by *EA* in the May 1982 issue.)

The Serviceman

It was all a frame-up

One of the more frustrating aspects of service work is the mystery fault — the fault for which there is no completely satisfactory explanation. Even when the actual cause is positively identified and corrected, it may not be possible to explain why the device exhibited the symptoms that it did; symptoms which, as in a recent case, appear to contradict all the rules.

As I have mentioned before in these notes, there seems to be no end to the surprises which particular appliances can produce, and this month's main story is a prime example. The set in question was an EMI model C211 colour set; the first colour set which this company released on the Australian market and which is now around 12 years old — a good age for any colour TV set. Nevertheless, there are still a lot of them around, giving good service and very highly thought of by their owners.

As with most of the first colour sets, the early batches had more than a reasonable number of faults. Some were straight out production faults, such as dry joints, but many were component problems, due to a few critcal components not meeting their maker's specifications. Most of these problems were sorted out in a few months, leaving us with no more than an average number of typical and mostly predictable, faults.

In fact, after 12 years, I reckoned I'd seen them all.

Strangely enough, many of the routine problems were associated with one section; the vertical oscillator board (PCB3) and its associated vertical output board, PCB11. One of the first of these problems, which showed up quite early, was loss of height. The makers issued a service note about this, pinpointing a 10μF electrolytic capacitor (C318) in a feedback circuit around the vertical output stage, as the culprit.

Rather more precisely, the effect was compression at the top of the picture and in this respect differs from another height problem, where the loss is more nearly equal at both the top and bottom. And, although a vertical problem, it does not involve either of the vertical boards.

Instead, it is on the line scan board. The 60V rail which supplies the vertical output stages is derived from a winding on the horizontal output transformer (T202) via diode D212, resistor R248 (75Ω), and smoothing capacitor C241, a 2200μF electrolytic. It is the electrolytic which goes sick and, in extreme cases, this shows up as a less than 60V rail. In fact, this was how the makers described the fault in their service note.

However, my experience is that the fault can be more subtle than that. The capacitor can fail to a degree which reduces the scan long before its effect shows up as a drop in voltage. I imagine that, since this capacitor provides the only return path for signals at the vertical frequency, loss of capacitance would restrict the output scan amplitude. So, a voltage check here, while it may be useful, should not be regarded as conclusive.

Another vertical fault which has shown up only in recent years is again a height problem, but is rather more erratic. It tends to be intermittent and may show up at the top of the picture, or at the bottom, or both, and may also vary in degree. In addition, the fault could sometimes be cleared by simply wiggling the vertical hold control (RV301).

In a few cases these symptoms were due to dry joints, or just a "noisy" hold control and were most easily fixed by simply exchanging the vertical oscillator board, this set using plug-in boards for ease of service. This would invariably cure the fault, but not always permanently. If the original board was really faulty it could be repaired and used for another service job, but in some cases no fault could be found. And, in such cases, the initial cure might last for up to twelve months, but would invariably return.

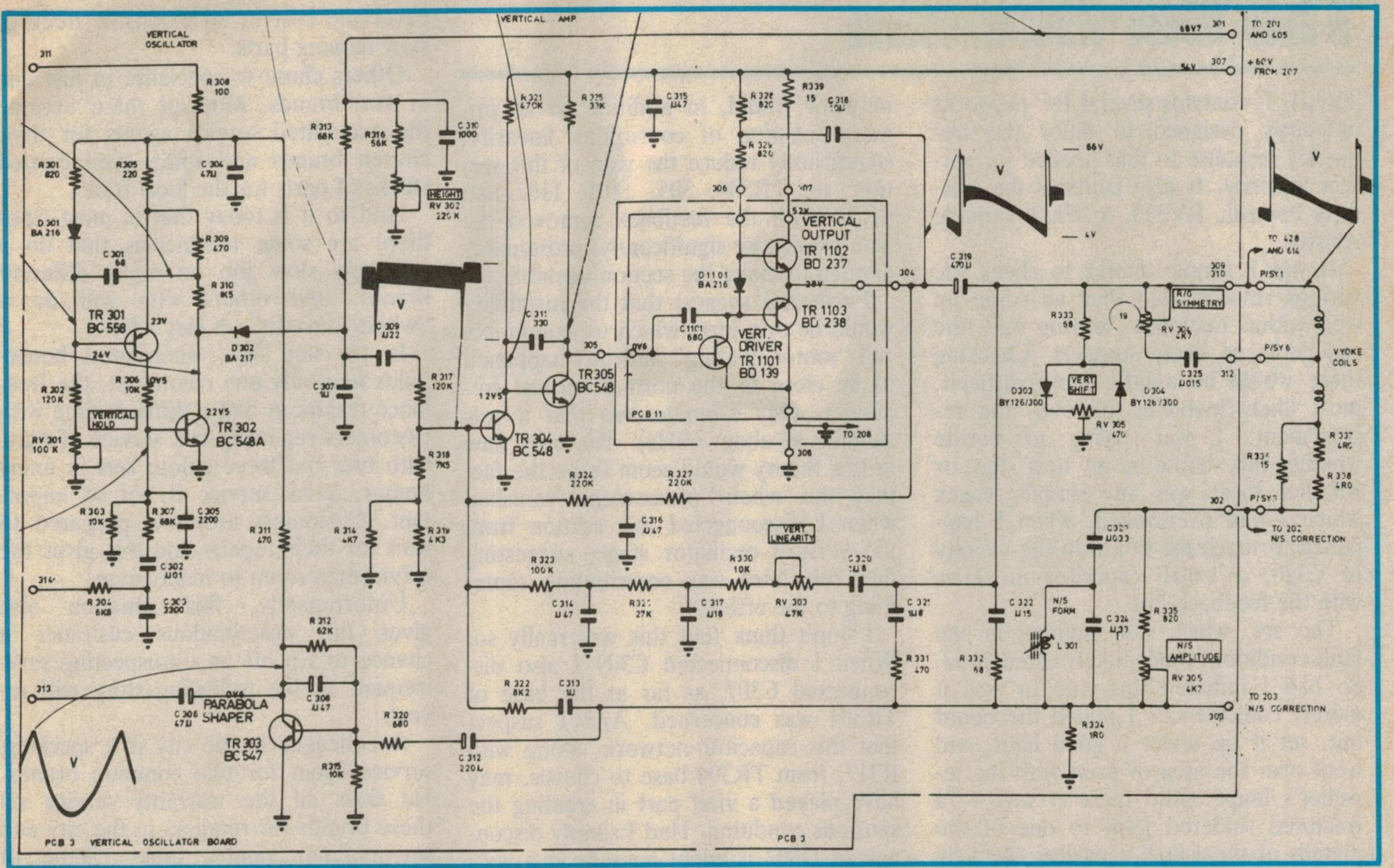
Tracking down the real cause of this problem took many months and involved several sets, but it was eventually pinpointed as being nothing to do with the boards themselves but, rather, the connectors into which the boards are plugged. Relatively speaking they are a good quality connector, but they can develop trouble with the passage of time. The treatment is to remove the board, then go over the connectors, clean them, and re-tension the springs. This treatment really works, giving years of trouble free operation.

Back to earth

So those are some of the tricky ones and, having encountered these and conquered them, I didn't imagine that there was much that this chassis could come up with that I couldn't handle in a routine manner. Which is just the kind of attitude which invites a down-to-earth bump.

And the bump was all the harder because the initial symptoms seemed innocuous enough; intermittent loss of vertical hold; ie, the picture would roll quite spasmodically for no apparent reason and for periods varying from a few seconds to several minutes. Granted, there was the intermittent factor but, according to the owner, the fault appeared quite frequently, so I didn't imagine it should be all that hard to find. I suspected that it would be either a fault in the vertical oscillator, whereby it was moving so far off frequency that it would no longer lock, or that there was loss of the vertical sync pulses for some reason. Neither should be hard to find.

The set refused to misbehave when I first tried it and, in fact, ran for several days before it failed. But when it did it didn't muck about; it rolled quite rapidly and much faster than most such faults. That was a minor surprise in itself, but there was more to come. The first thing I did was to vary the vertical hold control, only to find that it had absolutely no effect whatever.



Relevant portion of the EMI model C211 vertical oscillator and deflection circuitry. Note that PCB11 is a small separate board with a large heatsink for the output transistors (TR1102 and TR1103).

I opened the back of the cabinet and swung the chassis up into its service position, intending to make some checks with the CRO. However, the set had other ideas; when I switched it on again it was back to normal and nothing I could do would induce the fault. So I simply made sure I could reach the relevant parts of the board without moving anything and let the set run.

It didn't fail again until the next day, but when it did I was ready. One of the most accessible check points was at connector 314, where the sync pulses come in from the line scan board. Everything appeared to be normal here and I checked the pulses again at the base of TR302 — one of the two oscillator transistors — and found it spot-on as shown on the circuit.

So, why wasn't the oscillator locking? I moved the CRO lead over to the output of the oscillator circuit, to the junction of diode D302, C307 and C309. And that produced the real surprise. Not only was the signal exactly as shown on the circuit, but it gave every indication of being locked to the sync pulses.

Since the picture was still rolling I did a double check on this, but there was no doubt about it — the oscillator was firmly locked to the sync pulses.

Leaving the CRO probe where it was I connected the second trace lead to the vertical output stage on connector 304. The amplitude was correct here but, as I expected, it was clearly not locked. All of which amounted to a plainly ridiculous situation. How could the vertical amplifier and output stages continue to deliver a more or less normal output when they were clearly not being driven by the oscillator stage?

Spurious oscillator

It didn't take much thought to realise that there just had to be some form of spurious oscillator somewhere in the amplifier system which was strong enough to override the signals from the real vertical oscillator. But where and how?

My first guess was for the first amplifier stage, TR304. Seeking to confirm this idea I lifted one end of C309, which couples the vertical oscillator into this stage. If this particular stage, or the vertical system as a whole, was oscillating of its own accord, then it should continue to do so without any connection to the genuine oscillator stage.

So much for my theory. The trouble was it didn't work in practice. Lifting the capacitor produced exactly the effect one would expect had the system been operating normally — total frame collapse. So what the heck was going on? Not to put too fine a point on it, I didn't have a clue.

I was cogitating thus, and watching the picture roll merrily on its way, when I noticed something about the picture; to the extent that I could assess it while it was rolling it appeared to be significantly non-linear. Normally I would have dismissed such a symptom as being merely a byproduct of the main fault, but I had reached the stage where I was clutching at straws. Could this be an indication that the fault was in the linearity circuit?

The almost automatic reaction to this thought was to adjust the linearity control. And this produced the next surprise, because it appeared to have no effect whatsoever on the picture linearity. I felt I was getting somewhere now, even if I had done the right thing for the wrong reason. It seemed that there was something wrong with the linearity circuit and, if I could find and fix that, I might well find the rolling fault.

The linearity circuit is basically a feedback network from the output stage to the base of the first amplifier,

TR304. It contains several RC networks obviously designed to tailor the frequency response to that needed for correct linearity. It also contains the linearity control, RV303, a 47kΩ variable resistor.

It was a simple matter to check the various resistors and they all come up well within tolerance, leaving only the capacitors as likely suspects. Checking these would be a little more difficult, most likely involving removal and replacement. I was trying to decide whether this should be my next step, or whether there was any simpler check which I had overlooked, when I happened to touch the board in the vicinity of C320, a 1.8μF capacitor in series with the feedback line.

The set, which was running in the fault condition, immediately came good. So had I initiated this cure or was it merely coincidence? I pulled the board out, set it up under a good light, and went over the area of print with the jeweller's loupe. And there it was — a fractured soldered joint to one of the pigtails of the 1.8μF capacitor. And by "fractured" I mean that the joint looked as though it was initially sound, the solder having wet both the pattern and the pigtail. But something had moved the pigtail while the solder was setting, creating a fracture.

But I was still suspicious, if only because I couldn't see the connection between this fault and the symptoms. Was this the real fault, or was it a red herring, with the real fault lurking somewhere nearby? I reached for the soldering iron but, instead of repairing the joint, I cleared the solder away and pulled the pigtail out of the board. Then I put the board back in the set and tried again.

There seemed to be little doubt about it this time; the fault was back and no amount of mechanical abuse would alter it. I pulled the board out, resoldered the joint, checked it with the glass for anything else suspicious, then re-fitted it to the set. The set came good immediately and I felt reasonably confident that I had cured the fault, even if its exact mechanism was still a mystery. A prolonged run on the beach over the next several days convinced me that this was so.

An explanation

But why did it do what it did? The most likely explanation which I can offer is as follws: the linearity feedback network would, in addition to its primary function of controlling linearity, significantly reduce the gain of this section; ie, TR304, 305, 1101, 1102 and 1103. With the feedback removed the gain would rise significantly, presumably enough to make the section unstable.

Further, I suggest that the instability would be in a form which we commonly call "motor boating" and just happened to be close to the normal vertical frequency. (My estimate was that it was running at about 60Hz). The only flaw in this theory would seem to be the fact that the whole phenomena vanished when I disconnected this section from the vertical oscillator stage, suggesting that this later was contributing something to the effect.

I don't think that this was really so. When I disconnected C309 I also disconnected C307, as far as the base of TR304 was concerned. And I suspect that this capacitor network, along with R317, from TR304 base to chassis, may have played a vital part in creating the spurious condition. Had I simply disconnected D302 it might have been a very different story.

Of course, the set was long gone from the bench before I evolved this theory, so I have no way of confirming it. But if ever that set comes back, or I get another one like it, I'll be strongly tempted to have a bit of a fiddle in the hope that I can prove it. In the meantime I suggest readers make a note of it. You'll at least know where to start if you encounter it.

Ever been had?

And now, from one of my regular contributors, J.L. of Tasmania, comes a story with an unusual twist, and a warning about a trap, in the business sense, which is well worth noting. It is also interesting because the technical fault involved is very similar to one I described in the March 1987 notes. Here's how J.L. tells it:

With the advent of colour TV many servicemen had to make a difficult decision. The complexity of colour TV sets meant that we were going to face a spare parts problem — just how many parts can you hold in stock?

Most of us solved the problem in one of two ways. Some stocked only the barest minimum of common parts and relied on mail or freight services to deliver the rest. Customers had to wait, but that was better than paying the exhorbitantly high charges needed to cover the cost of an extensive stock of slow moving parts.

Others chose to specialise in just one or two brands. Most of these became the accredited service agents for their chosen brands and some even carried stocks of parts for the local trade.

And so it is today that in most cities there are some technicians that do a relatively slow job on many different brands, and others who will do a "while-you-wait" on just a few.

In the late 70's, when most households had only one colour set, the freelance technican had a difficult time with customers requiring fast service. Today, with two and three colour sets in many homes, quick service is not so important. Customers are now prepared to wait for their repairs and this gives the serviceman room to manoeuvre.

Unfortunately, this situation also gives the unscrupulous customer a chance to rip off an unsuspecting serviceman, as the following story will reveal.

A colleague in the city is a specialist service agent for two common brands. He does all the warranty service on these brands for retailers in the city and surrounding country areas. Some of these retailers, particularly those in the country, also take in general service work and pass it over to my friend.

This general work poses no problems so long as it involves the brands he knows. But if the sets are "aliens", he passes the work over to me. Also, he sometimes takes foreigners over his own counter and gives these to me. So all in all, I do pretty well out of his business.

Several months ago he asked me to look at a Rank Arena that had come down from one of his country retailers. It was a Model 2206 with symptoms reported as "loud cracking or banging" in the back of the set or, in technical terms, EHT leakage. In the Rank, this is almost always due to a cracked tripler case.

Unfortunately, the set would not work at all in my workshop. Equally unfortunate was the fact that the tripler was immaculate — not the tiniest sign of a crack. No pinholes, nothing. So if there was EHT leakage, it was not from the tripler.

In the event the fault was not particularly difficult to find. It involved checking the transistors and filter capacitors in the power supply, line output stage, and vertical output section. When each of these checked OK, with no shorts and no other major faults, it had to be a protection circuit problem.

This particular Rank model has a

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BF494	.21
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2N5303	5.40
2N5401	.79
2N5457	.79
2N5458	.57
2N5459	.57
2N5484	.58
2N5485	.80
2N5486	.65
2N5589	20.90
2N5590	21.60
2N5591	24.50
2N5770	.52
2N5777	1.25
2N5830	.32
2N5831	.32
2N5873	1.76
2N5874	1.40
2N5944	12.90
2N5946	27.00
2N5961	.36
2N6027	1.08
2N6028	1.00
2N6080	15.40
2N6083	18.25
2N6084	26.60
2N6121	.82
2N6122	1.05
2N6123	1.05
2N6124	.89
2N6125	.91
2N6126	.84
2N6129	.99
2N6130	1.35
2N6131	.90
2N6133	.90
2N696	1.03
2N697	.83
2N918	.26
2SC1061	.97
2SD325	.72
2SD350A	5.56
2SD353	3.90
2SJ49	7.20
2SJ56	9.96
2SK134	6.38
2SK176	8.90
CMOS-4000	
4000	.42
4001	.42
4002	.42
4006	1.42
4007	.42
4008	1.21
4009	.65
4010	.42
4011	.42
4012	.42
4013	.63
4014	1.31
4015	1.34
4016	.62
4017	1.23
4018	1.80
4019	.75
4020	1.29
4021	1.05
4022	1.37
4023	.53
4024	1.21
4025	.53
4026	1.45
4027	.80
4028	1.10
4029	1.16
4030	.69
4031	2.45
4032	2.29
4033	1.97
4034	2.92
4035	1.63
4040	1.10
4041	1.07
4042	1.25
4043	1.10
4044	1.16
4046	1.61
4047	1.00
4048	.89
4049	.53
4050	.83
4051	1.25
4052	1.25
4053	1.25
4055	3.25
4060	1.75
4063	1.66
4066	.75
4067	7.08
4068	.66
4069	.66
4070	.75
4071	.45
4072	.66
4073	.53
4075	.44
4076	1.79
4077	.66
4078	.44
4081	.45
4082	.44
4085	1.83
4086	1.91
4089	2.85
4093	.75
4094	2.50
4098	2.41
4099	2.60
4104	4.58
4160	1.40
4161	1.37
4162	1.40
4163	1.64
4174	1.25
4194	1.62
4411	10.40
4419	2.87
4469	12.08
4495	3.29
4500	7.40
4502	1.42
4503	1.09
4507	.75
4508	3.39
4510	1.26
4511	1.37
4512	1.16
4514	2.42
4515	2.40
4516	1.37
4518	1.44
4519	.89
4520	1.37
4521	2.91
4522	1.68
4526	1.34
4527	1.93
4528	.95
4529	1.76
4531	1.37
4532	2.20
4534	7.40
4536	5.40
4538	1.55
4539	1.40
4541	1.45
4543	2.08
4553	4.55
4555	1.02
4556	1.04
4558	1.87
4560	3.12
4569	2.08
4572	.85
4583	1.34
4584	.80
4585	1.75
4599	2.87
4702	5.72
4703	15.40
4723	1.68
4724	1.68
4725	7.40
4731	9.58
40014	1.92
40085	1.62
40097	1.09
40098	1.62
40106	1.92
40160	1.13
40161	1.37
40163	1.64
40174	1.21
40192	1.80
40193	1.68
40194	1.58
CMOS-74C	
74C00	.58
74C02	.66
74C04	.66
74C08	.80
74C10	.65
74C14	1.92
74C20	.76
74C30	.61
74C32	.76
74C42	1.63
74C48	2.47
74C73	1.07
74C74	1.30
74C76	1.23
74C83	2.07
74C85	1.62
74C86	.75
74C89	7.40
74C90	2.40
74C93	1.72
74C95	1.91
74C107	1.10
74C150	4.62
74C151	2.89
74C154	4.55
74C157	3.53
74C160	1.13
74C161	1.37
74C162	1.50
74C163	1.64
74C164	1.05
74C165	1.72
74C173	1.79
74C174	1.25
74C175	1.21
74C192	1.80
74C193	1.65
74C195	1.62
74C200	9.03
74C221	2.65
74C240	2.72
74C244	2.72
74C373	3.19
74C374	2.91
74C901	1.06
74C902	.95
74C903	1.50
74C904	1.14
74C905	8.82
74C906	.96
74C907	.94
74C908	2.02
74C910	10.55
74C911	10.03
74C912	16.95
74C914	2.34
74C915	2.25
74C917	7.83
74C918	2.13
74C920	5.31
74C921	3.96
74C922	7.26
74C923	8.46
74C925	8.09
74C926	9.90
74C927	7.40
74C928	4.99
74C929	5.36
74C930	5.22
74C932	1.66
74C941	2.61
74C946	18.29
74C989	6.46
CMOS-74HC	
74HC00	.50
74HC02	.50
74HC04	.50
74HC08	.53
74HC10	.53
74HC11	.53
74HC14	1.35
74HC20	.50
74HC27	.53
74HC30	.53
74HC32	.58
74HC42	.105
74HC51	.63
74HC74	.74
74HC76	.80
74HC85	1.16
74HC87	.79
74HC107	.87
74HC112	.64
74HC123	1.36
74HC125	1.10
74HC132	1.40
74HC138	.90
74HC139	.90
74HC147	2.04
74HC148	1.71
74HC151	1.19
74HC153	1.13
74HC157	1.13
74HC158	1.05
74HC160	1.58
74HC161	1.58
74HC162	1.58
74HC163	1.68
74HC164	1.61
74HC165	2.26
74HC173	1.38
74HC174	1.31
74HC175	1.31
74HC192	1.34
74HC193	1.35
74HC194	1.21
74HC195	1.18
74HC221	1.95
74HC240	2.36
74HC241	2.36
74HC242	1.86
74HC243	1.86
74HC244	2.31
74HC245	2.31
74HC251	1.34
74HC253	1.34
74HC257	1.19
74HC258	1.14
74HC259	1.50
74HC266	.87
74HC273	2.24
74HC356	3.28
74HC365	1.07
74HC366	1.34
74HC367	1.34
74HC368	1.34
74HC373	1.76
74HC374	1.87
74HC375	1.14
74HC390	2.58
74HC393	2.36
74HC533	3.05
74HC573	2.81
74HC574	2.81
74HC640	3.36
74HC670	1.84
74HC4002	2.00
74HC4017	2.00
74HC4020	2.00
74HC4022	1.64
74HC4024	1.89
74HC4040	2.39
74HC4049	1.70
74HC4050	2.98
74HC4051	1.37
74HC4052	1.77
74HC4053	1.77
74HC4060	2.36
74HC4066	1.15
74HC4075	1.15
74HC4078	1.15
74HC4511	2.50
74HC4538	2.76
74HC4543	3.05
74HCT240	2.63
74HCT244	2.63
74HCT245	2.31
74HCT573	2.31
74HCT574	2.17
74AC SERIES	
74AC00	.82
74AC04	.82
74AC08	.82
74AC14	.82
74AC32	.82
74AC74	1.05
74AC109	1.05
74AC138	1.05
74AC139	1.05
74AC153	1.40
74AC157	1.40
74AC158	1.40
74AC161	1.42
74AC240	1.92
74AC241	1.92
74AC244	1.92
74AC245	2.52
74AC253	1.40
74AC257	1.37
74AC258	1.37
74AC299	4.62
74AC373	2.08
74AC374	2.08
74AC573	1.94
74AC574	1.94
7400 TTL	
7400	.75
7401	1.07
7402	1.21
7403	.75
7404	.89
7405	.68
7406	.95
7407	1.00
7408	1.03
7409	.95
7410	.50
7411	.68
7412	.50
7413	.66
7414	2.02
7413	.66
7414	2.02
7416	.92
7417	1.00
7420	.66
7421	.66
7423	.75
7425	.75
7426	.68
7427	.84
7430	.89
7432	1.03
7437	1.12
7438	.98
7440	1.07
7441	1.43
7442	1.31
7443	1.93
7444	1.25
7445	1.86
7446	1.00
7447	1.25
7448	1.58
7450	.75
7451	1.00
7453	.71
7454	.60
7460	.60
7470	.60
7472	.98
7473	.79
7474	.95
7475	1.37
7476	1.31
7480	1.65
7482	3.15
7483	.75
7485	1.28
7486	1.05
7489	3.25
7490	1.21
7491	.83
7492	1.18
7493	.96
7494	1.25
7495	1.10
7496	1.12
7497	1.90
7410	.82
74109	.68
74121	1.24
74122	.84
74123	1.06
74125	1.16
74126	1.00
74132	1.10
74141	.91
74145	2.47
74147	1.62
74148	1.66
74150	2.05
74151	1.18
74152	6.83
74153	.91
74154	3.80
74155	1.42
74156	.99
74157	1.16
74160	.65
74161	1.24
74162	.71
74163	1.60
74164	1.31
74165	1.16
74166	1.21
74167	1.83
74170	2.52
74173	1.20
74174	.96
74175	1.16
74176	.82
74177	1.16
74178	1.90
74180	1.26
74181	3.30
74182	1.00
74184	4.00
74185	3.63
74189	4.60
74190	1.81
74191	1.26
74192	1.33
74194	1.33
74195	1.33
74196	1.00
74197	1.54
74198	.91
74199	1.22
74221	1.58
74251	1.84
74279	1.26
74283	2.08
74284	5.48
74285	4.58
74290	.75
74293	.75
74298	2.04
74365	.93
74366	.93
74367	1.10
74368	.83
9316	1.65
9368	1.73
9602	2.08
9636	3.12
9637	4.38
9638	3.16
74LS-SERIES	
74LS00	.50
74LS01	.55
74LS02	.50
74LS03	.50
74LS04	.50
74LS05	.56
74LS08	.50
74LS09	.56
74LS10	.53
74LS11	.49
74LS12	.68
74LS13	.58
74LS14	.61
74LS15	.50
74LS20	.50
74LS21	.75
74LS22	.75
74LS26	.75
74LS27	.58
74LS28	.75
74LS30	.60
74LS32	.60
74LS33	.66
74LS37	.61
74LS38	.65
74LS40	.66
74LS42	.66
74LS47	1.40
74LS48	1.37
74LS49	1.60
74LS51	.56
74LS54	.62
74LS55	.54
74LS73	.58
74LS74	.50
74LS75	.61
74LS76	.48
74LS78	.68
74LS83	.80
74LS85	1.10
74LS86	.50
74LS90	.87
74LS91	.75
74LS92	.72
74LS93	.77
74LS95	.80
74LS96	.98
74LS107	.92
74LS109	.60
74LS112	.96
74LS113	.69
74LS114	.66
74LS122	2.10
74LS123	.86
74LS125	.63
74LS126	1.03
74LS132	.71
74LS133	.61
74LS136	.80
74LS138	.66
74LS139	.80
74LS151	.84
74LS152	1.60
74LS153	.84
74LS154	1.32
74LS155	.92
74LS156	.63
74LS157	.82
74LS158	.84
74LS160	.71
74LS161	.71
74LS162	.71
74LS163	1.05
74LS164	.98
74LS165	1.00
74LS166	1.12
74LS169	2.21
74LS173	1.13
74LS174	.78
74LS175	.68
74LS181	3.55
74LS190	1.19
74LS191	1.42
74LS192	1.17
74LS193	1.13
74LS194	1.19
74LS195	.79
74LS196	1.19
74LS197	.86
74LS221	1.62
74LS240	1.49
74LS241	1.55
74LS242	1.63
74LS243	1.58
74LS244	1.40
74LS245	1.71
74LS247	1.58
74LS248	1.25
74LS249	2.47
74LS251	.63
74LS253	.77
74LS257	.68
74LS258	.68
74LS259	1.08
74LS260	.70
74LS266	.79
74LS273	1.37
74LS279	.58
74LS283	.66
74LS290	1.03
74LS293	1.00
74LS295	.89
74LS298	.84
74LS323	5.49
74LS352	.82
74LS353	1.05
74LS365	.79
74LS366	.89
74LS367	.77
74LS368	.67
74LS373	1.33
74LS374	1.40
74LS375	.87
74LS377	1.40
74LS378	1.73
74LS379	.79
74LS386	1.45
74LS390	.79
74LS393	1.10
74LS395	1.55
74LS447	1.24
74LS490	1.00
74LS573	1.60
74LS574	2.29
74LS629	4.95
74LS640	2.90
74LS670	1.19
74F-SERIES	
74F00	.88
74F02	.96
74F04	.95
74F08	.95
74F10	.82
74F11	.90
74F20	.90
74F32	.96
74F64	1.08
74F74	1.13
74F86	1.21
74F109	1.34
74F138	1.20
74F139	1.20
74F151	1.10
74F157	1.26
74F158	1.40
74F160	2.08
74F161	2.08
74F162	2.08
74F163	2.75
74F164	1.47
74F174	2.54
74F175	1.60
74F181	4.95
74F182	1.52
74F189	3.52
74F190	2.57
74F191	2.34
74F194	3.10
74F240	3.75
74F241	4.39
74F243	3.62
74F244	3.02
74F245	4.39
74F251	1.50
74F253	1.21
74F257	1.89
74F258	1.26
74F283	1.26
74F350	1.63
74F352	1.19
74F353	1.19
74F373	3.34
74F374	3.34
74F379	1.50
74F381	4.18
74F382	4.18
74F398	2.18
74F399	1.52
74F521	2.08
74F533	2.81
74F534	5.46
74F537	4.76
74F538	4.76
74S-SERIES	
74S00	.95
74S02	1.34
74S03	1.21
74S04	.89
74S05	.80
74S08	.95
74S10	.78
74S11	.86
74S15	1.33
74S20	.78
74S30	.98
74S32	.90
74S40	1.03
74S51	.98
74S64	1.03
74S74	.90
74S86	1.29
74S109	1.79
74S112	1.80
74S113	1.08
74S132	1.20
74S133	1.42
74S135	2.76
74S138	1.60
74S139	1.94
74S140	1.82
74S151	1.73
74S153	1.29
74S157	1.68
74S158	1.61
74S161	4.95
74S174	1.73
74S175	1.66
74S188	3.40
74S189	7.08
74S194	3.08
74S241	5.75
74S242	3.29
74S253	1.55
74S257	1.40
74S258	1.25
74S283	6.58
74S287	4.08
74S288	3.68
74S289	5.79
MEMORY	
2102	2.08
2114	2.45
2708	12.50
2716	8.95
2732	8.99
2532	10.40
2764	7.95
27C64	8.51
27128	10.00
27256	12.03
27C256	13.80
27512	34.00
4116	3.29
4164	2.75
41256	6.95
4464 64Kx4 DYN RAM	8.87
6116	4.73
6264	7.56
62256	37.00
6800 SERIES	
6800	10.14
6802	10.14
6808	9.58
6809	15.22
6810	4.81
6820	3.50
6821	5.60
6840	9.00
6844	14.49
6845	10.60
6847	7.08
6850	6.35
6854	13.44
6875	12.45
68B00	11.50
68B02	11.50
68B09	15.60
68B10	5.06
68B21	5.90
68B40	10.50
68B44	37.50
68B45	16.50
68B50	8.50
CMOS 6800 SERIES	
HD6303R	19.80
6305 x 2	17.03
6321	7.60
6350	7.79
63A03RP	19.16
63A21	6.65
63A50	7.41
63B09	19.98
63B50	12.14
Z80 SERIES	
Z80A CPU	3.50
Z80A PIO	3.50
Z80 ATC	3.50
Z80A SIO	7.95
Z80A DMA	13.50
Z80A DART	7.95
Z80B CPO	5.95
Z80B PIO	5.95
Z80B CTC	6.25
Z80B SIO	9.50
Z80B DART	9.50
LINEAR & SPEC. FUNC.	
LH0002N	11.10
LH0042CH	9.95
LH0070H	9.74
LH0071H	13.30
TL061	1.25
TL062	2.33
TL064	3.90
TL071	1.86
TL072	2.47
TL074	3.41
TL081	1.30
TL082	1.20
TL084	2.66
SAB0600	6.16
ADC0800	19.10
ADC0804LCN	6.98
ADC0808CCN	12.62
DAC0800LCN	4.15
DAC0808LCN	3.36
LM10CH	10.15
MC10116	2.10
11C90	9.95
DAC1220LCN	15.56
LM13600N	1.82
LF13741N	.97
SAK140	7.90
MC1320P	6.58
MC1350P	1.35
DAC1408	3.60
MC1445L	4.95
MC1456	1.62
UA1458TC	.90
MC1466	17.50
UA1488PC	.80
UA1489PC	.80
MC1494	6.95
MC1495	7.40
MC1496	1.00
TR1602	7.70
WD1691	24.58
UAA170	4.95
FD1772	29.50
FD1791	16.50
FD1793	16.50
FD1795	25.00
FD1797	25.00
UAA180	3.12
LM1830	3.42
TR1863	7.40
LM1886	6.25
LM1889	2.47
BR1943	12.45
TDA2002	2.90
ULN2001	1.37
ULN2002	2.33
ULN2003	2.00
ULN2004	1.50
WD2143	18.50
TCA220	7.90
TDA2030	4.58
XR2206	6.55
XR2211	5.50
SP0256A-AL2	12.50
CTS256-AL2	22.00
WD2791	49.00
WD2793	29.00
WD2795	57.50
WD2797	32.00
UA2902PC	1.10
LM2917N-8	3.16
LM2917N-14	3.00
MN3001	14.58
LM301AN	1.33
UA301AHC	2.60
LM307N	.90
LM307H	1.43
LM3028	1.66
CA3046	1.50
CA3059	4.95
LM3080	1.57
UA3086	.60
LM3089N	3.20
UA308TC	.80
UA308HC	1.86
UA308ATC	3.08
UA308AHC	4.94
LM310N	2.65
AY3-1015D	7.70
UA311TC	.88
UA311HC	2.47
LM318N	3.03
LM319N	3.35
CA3130E	1.85
CA3130T	2.80
CA3140E	1.10
CA3140T	2.20
UA324PC	.60
LM325N	5.25
LM329DZ	.75
LM334Z	1.27
MC3340	1.54
LM335Z	2.22
OM335	18.30
LM336Z-2.5	1.55
UA339PC	.70
UA339ADC	3.10
LM3401N	1.18
LF347N	2.07
MC3470	5.95
UA348PC	2.02
LM349N	1.38
OM350	8.33
LF351N	1.20
LF353N	1.35
LF356N	2.87
LF357N	2.11
LM358N	.60
LM377N	3.76
LM378N	5.17
LM380N-8	1.48
LM380N-14	1.48
LM381N	3.97
LM382	3.22
LM383T	3.95
LM384N	2.95
LM386N-3	1.37
LM387N	2.22
LM388N-1	.85
LM389N	2.03
AY3-8910	12.05
LM3900N	1.18
LM3905N	1.80
LM3909N	1.67
LM3911N	2.87
LM3914N	3.85
LM3915N	3.23
LM3916N	3.78
LM391N-60	1.66
LM393N	1.03
LM394CH	5.60
LM398N	2.03
UA4136	1.40
ZN414	1.12
LM4250	2.87
4412	11.62
MM5303N	6.25
MM5309N	11.60
MM5369EST	
	4.12
NE5532AN	2.90
NE5534	1.80
NE5534AN	2.60
LM555N	.50
UA556PC	.92
NE558	3.50
NE565	1.33
NE566	2.25
NE567	1.58
NE570	4.91
NE571	4.90
MM58167N	11.52
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6522A	12.50
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6545	14.00
6551	14.50
UA709TC	1.24
UA710PC	1.61
ICL7106	16.25
TA7205	3.25
ICM7216B	55.62
ICM7217A	21.46
LM711N	2.84
LM711H	2.26
UA733PC	1.98
UA739PC	3.40
UA741TC	.41
UA741HC	2.60
LM747N	1.87
UA75107BPC	1.73
UA75110APC	2.04
75150	1.54
UA75154PC	1.54
UA75451BTC	1.49
UA75452BTC	1.49
UA75453BTC	1.49
UA75461TC	1.49
UA75462TC	1.52
UA75491PC	1.52
UA75492PC	1.52
ICM7555	1.10
ICM7556	2.45
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SN76488	6.20
EF7910 MODEM CHIP	21.75
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DM8130N	5.26
DM8131N	4.50
DM8136N	4.27
8155	5.40
8156	8.75
81LS95	2.38
81LS96	2.42
81LS97	2.51
81LS98	2.26
8202	2.83
8212	2.40
8214	1.20
8216	4.15
8224	2.90
8226	3.75
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"High Voltage Protector" circuit intended to shut down the oscillator if the EHT rises above a certain figure. This circuit contains two transistors and a few other components but it is one of the transistors that really gets me going. It's a 2SA539 (TR2001) and it must be one of the most unreliable transistors ever made. The transistor checks OK, but will not work.

Anyway, I replaced this transistor, refitted the board and eventually returned the set to my colleague.

Service label

One of the last things I do before returning sets to my own customers is to attach a label carrying my name and phone number. These particular personal stickers are inappropriate for "third party" jobs so I use my computer to print labels with my colleague's name and address, but with my job number and the date. These labels stick pretty tightly, but they can be rubbed off so they are not an infallible identity.

I've been doing this for many months and sometimes wondered if it was worthwhile. But recently something happened that settled the problem once and for all. It's not only worthwhile but absolutely essential.

A few days ago the Rank set was back again, or so I was told. It had come back from the same customer, through the same country retailer and the fault was still the same — EHT leakage. It was supposed to be the same set that I had serviced two months earlier although it was not carrying my job number sticker.

I suppose that I would have been justified in refusing it as a warranty job as I usually allow only 30 days for returns. But my friend gives me plenty of work so I didn't quibble over this one small job.

Back in my workshop, I opened the set and found a cracked tripler. I suppose that was fair enough. The crack could have been invisible two months earlier and opened up since. But the main problem was that the set would not fire up. In fact it was a repeat of the last job — a faulty TR2001.

Now, I will swear on a stack of service manuals that this was an original transistor. It had never been replaced — certainly not by me just two months earlier.

Unfortunately, these Rank sets (and some other brands) have their model and serial numbers on stickers on the back of the cabinet. Over the years these have peeled off and been lost so that one Rank looks much like any other. In this circumstance there is nothing to stop an unscrupulous customer from getting two sets repaired for the price of one.

In this case I had no proof that this was a second set. I had strong suspicions, but without a serial number or my label still attached it was the customer's word against mine.

It was just coincidental that both sets had the same fault, requiring replacement of the same transistor. If it had been only the tripler I might have accepted my bad luck and had no reason to doubt that it was the same set.

From now on, I will put my own serial number inside any set that does not have the manufacturer's number clearly and firmly affixed to the back cover. And if someone wants to pull a swifty, they will have to try it on within the 30 days limit. I've been had once too often.

Thank you J.L. I don't think there is much I need add, except to shift a well known warning through 180 degrees and say, "Let the dealer beware".

Reader comments

And now for a few other readers' comments. From Mr B.S. of Woolgoolga, NSW comes a brief comment about my story in the January 1987 notes. He writes:

I have just read your story in the January 1987 issue of EA concerning the horizontal sync fault with a Philips KL9A colour TV set.

I have had this same fault twice in the last two years and both sets were only a hundred metres from the ocean. Both faults, I consider, were caused by salt corrosion. The fault was reported to TESA and was printed in the first new list of Service Tips.

Thank you, B.S. I'm sure other readers will appreciate confirmation of what I found. It is also good to know that the fault has been published elsewhere.

The next comment comes from Mr J.D. of Auckland NZ and is something of a "funny", illustrating how easy it is to be misled. He writes:

I've read you column, avidly, over many years and have always admired your logical, sane, and simple approach to the many problems that confront you and your colleagues. I am convinced that electronic servicing is one of the most demanding and complex jobs around. Good servicemen must surely be worth their weight in gold.

I am a retired aircraft engineer who took up electronics as a hobby about two years ago. I recently made up the Claytons Car Alarm from the February 1986 EA for a friend who cannot afford a full size system.

I then realised that, by substituting a beeper for the lamp and by tying the unit into my car's headlight circuit, I could avoid a flat battery; something which had happened to me recently.

I had a spare printed board — I always make two — and, while working on it, I set up the first unit, flashing away merrily, connected by long leads to a power supply. Satisfied that it was working I put it to one side, still flashing, on my bed. Whereupon, it stopped flashing!

I switched off the power, checked the board and leads to the power supply, switched on again and all was well. I put it aside again and, as before, it immediately stopped flashing.

This ritual was repeated several times, with no fault being found in the board, the leads, or the power supply. Then I happened to lift the board clear of the bed while power was till applied. At several centimetres above the bed the board started flashing, but at half the normal rate. I raised it about 30cm and it flashed normally.

I eventually realised that my electric blanket had been left on, creating a magnetic field which interfered with the 555 on the board, possibly through pin 5.

I thought this story might provide some light relief from the heavy problems you encounter. I enjoy your column immensely, even though I do not always grasp the technicalities involved.

Thank you, J.D. for a most interesting story. I'm sure most of us have been caught out by equally silly situations on more than one occasion: I know I have.

And thanks for the kind comments J.D. It's nice to know somebody out there still likes me.

TETIA Fault of the Month

National TC2054 (PBA-V1 Chassis)
Symptom: Tuning erratic and shifted to lower end of tuning range. Only snow and noise in the normal channel positions. If retuned, VHF channels can be found near the bottom of each band.
Cure: Q7 (2SC1685) leaky base/emitter. In the fault condition, b/e voltages are 0.6V apart, but just above ground. Proper levels are 6V for channel 2 and 10 plus volts for higher VHF channels. A BC547 can be used as a replacement in this position.

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Pack 300 E48 1% resistors	R-7015	$17.55	$11.60
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Mini Electric Motor	J-1041		$1.50
27k 1W resistor	R-1508	12¢	5¢
8.2k 5W wire wound resistor	R-1708	60¢	5¢
1.8k ½W resistor	R-1280	7¢	5¢
680 ohm 1W res	R-1470	12¢	5¢
500k linear pot imp	R-1812	$1.20	70¢
100k log pot imp	R-1824	$1.20	70¢
20k dual linear pot (imp)	R-1836	$1.20	70¢
100k dual linear pot (imp)	R-1840	$1.20	70¢
10k dual linear pot (imp)	R-1834	$1.20	70¢
10k dual log pot (imp)	R-1849	$1.20	70¢
50k dual log pot (imp)	R-1853	$1.20	.70
1M log switch pot (imp)	R-1888	$2.40	70¢
100k multiturn trimpot	R-1910	$1.25	70¢
50k log pot (imp)	R-1823	$1.30	70¢
2M linear pot (imp)	R-1814	$1.30	70¢
10k log pot (imp)	R-1820	$1.30	70¢
1M linear pot (imp)	R-1813	$1.30	70¢
10k log pot (metric)	R-6820	$1.30	70¢
10k linear pot (imp)	R-1806	$1.20	70¢
20k dual linear pot (metric)	R-6836	$2.85	70¢
1k linear pot (imp)	R-1803	$1.30	$1
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100k 10mm vertical trimpot	R-1965	55¢	35¢
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4700uF 35V electrolytic	R-4215	$4.35	$2.10
33uF 10V electrolytic	R-4330	30¢	5¢
22uF 25V electrolytic	R-4319	30¢	5¢
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33uF 10V tantalum capacitor	R-4765	95¢	70¢
2uF greencap (100V)	R-2140	$1.90	$1
47uF 350V electrolytic	R-4120	$2.50	$1
2200uF 35V electrolytic	R-4459	$1.35	35¢
1000uF 16V electrolytic	R-4175	$1.05	35¢
2200uF 16V electro (RT)	R-4459	$1.35	35¢
2200uF 16V electrolytic (RB)	R-4196	$1.40	35¢
330uF 25V electro	R-4400	75¢	35¢
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47uF 25V electrolytic	R-4350	35¢	10¢
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.056uF greencap 100V	R-2085	30¢	10¢
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74LS123 IC	Z-5310	$1.45	$1.00
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LM335H temp sensor	Z-6050	$4.45	$2.35
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TLC251 op amp IC	Z-6021	$5.15	$2.35
TBA820M audio IC	Z-2506	$4.45	$2.55
LM394C IC	Z-6083	$7.15	$7.15
74LS244 IC	Z-5294	$2.75	$1.55
74C173 IC	Z-5376	$1.50	$1.50
74193 IC	Z-5280	$2.05	$1.50
74HC244 IC	Z-5950	$3.85	$1.30
76604N IC	Z-6835	$6.53	$2.39
LM3600 IC	Z-6113	$2.75	$1.50
4543 IC	J-1070	$4.50	$4.00
74LS373 IC	Z-5295	$2.75	$1.00
74LS241 IC	Z-5293	$1.00	70¢
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74109 IC	Z-4109	$1.55	70¢
4520 IC	Z-5742	80¢	70¢
74LS175 IC	Z-5291	$1.50	70¢
4024 IC	Z-5624	$1.30	70¢
4528 IC	Z-5748	$2.75	$1.00
74LS373 IC	Z-5295	$2.75	$1.00
4051 IC	Z-5651	$1.95	$1.00
LM308 IC	Z-6045	$1.65	$1.00
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CA3140 IC	Z-5417	$1.95	$1.00
74LS10 IC	Z-4910	85¢	35¢
74LS08 IC	Z-4908	85¢	35¢
74LS14 IC	Z-4914	85¢	35¢
74HC367 IC	Z-5960	80¢	35¢
7401 IC	Z-5011	35¢	35¢
74LS31 IC	Z-4931	55¢	35¢
7410 IC	Z-5020	90¢	35¢
7408 IC	Z-5018	70¢	35¢
74LS06 IC	Z-4900	75¢	35¢
7400 IC	Z-5010	35¢	10¢
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BC337 trans	Z-2190	40¢	10¢
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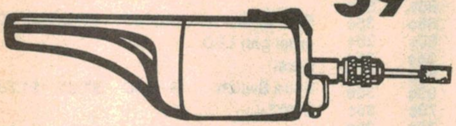

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- **12-35V DC operated (external)**
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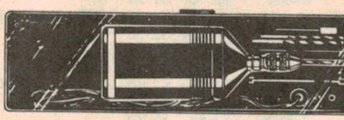

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1.1mm Cat T-4819
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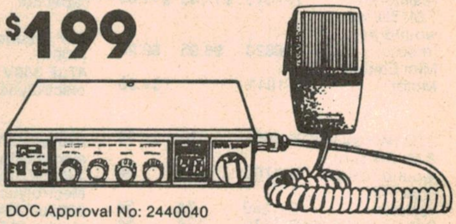

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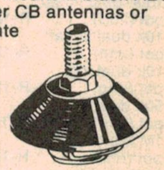
Light Duty Antenna Base

Standard 5/6" 26TPI threaded mount in black ABS base. Suits ¼ wave and smaller CB antennas or small VHF whips. Mounting plate includes solder lugs for coax connection. Cat D-4056

$3.50



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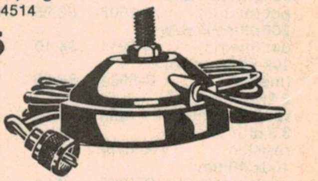
A quality magnetic base — ideal for the company car where holes aren't allowed! Complete with 2m coax and PL-259 plug. Standard thread suits most antennas. Cat D-4514

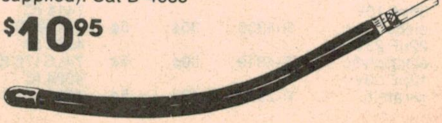
$34.95



Rubber Duck Antenna

Here's a tiny one...just 33cm long! Helically wound, extremely flexible. Standard 5/16" base (not supplied). Cat D-4635

$10.95



WIRE

VARIOUS HOOK-UP WIRES

10 x 0.12 (equiv. 10 x .0048) PVC hook up wire for projects, repair, hanging the washing on ...anything!

W-2220 **RED**
W-2221 **BLACK**
W-2222 **BROWN**
W-2223 **ORANGE**
W-2224 **YELLOW**
W-2225 **GREEN**
W-2226 **BLUE (DARK)**
W-2227 **PURPLE**
W-2228 **BLUE**
W-2229 **GREY**
W-2230 **CREAM**
W-2231 **WHITE**

$3.50 PER 100m ROLL
OR 10¢ PER METRE

The Best Test On 2!

The Oskerblock SWR-145 keeps you up to date! Designed to be left 'in-situ' for permanent readings. With a top range on two metres of 250 watts and, for VHF users, it needs very low power for full scale readings!
Cat Q-1341

$99

VHF Hand-held Power Meter.

Weltz quality, the ultimate versatility and DSE value! Check the output of your hand-held accurately — just connect the TP-05X in place of your antenna and you've got it! Cat Q-1343

$29

Lightweight Spring

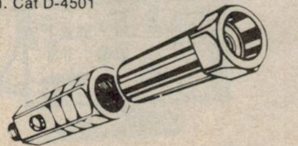
Designed to suit standard loaded ¼ wave mobile whips, to give the type of flexibility required in today's low car parks! Cat D-4500

$7.95

Quick Disconnect

Enables you to remove your antenna from its mount with an easy press and twist. Saves your antenna being stolen. Cat D-4501

$10.95



Budget Priced 3.5 Digit

This just goes to prove that you don't have to spend a fortune on quality test equipment! Pocket sized with easy one hand operation the 3.5 digit wide-angle LCD gives accurate readings at a glance. With overload protection, RF shielding, all ohm ranges handle 250V AC or 350V DC indefinitely and much, much more! Cat Q-1515

- **2, 20, 200, 1000V DC**
- **2, 20, 200, 750V AC**
- **Resistance: 2, 20, 200k, 2M**
- **Robust housing**
- **Much more!**

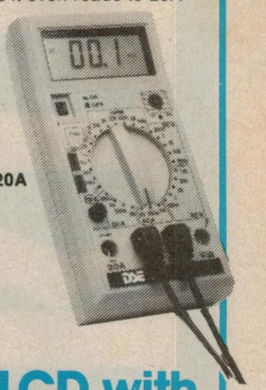
$69

At last! Frequency reading DMM!

It's finally happened: a digital multimeter with frequency reading...as well as all the advanced features of a top DMM (capacitance, transistors & diodes, continuity, etc). Also features direct frequency readout to 200kHz. Ideal for audio and general service work. And it even reads to 20A AC/DC! Cat Q-1505

- **Frequency to 200kHz**
- **Current to 20A**
- **Transistors, diodes & capacitance too.**
- **AC: 2, 200mA, 20A**
- **Transistors: Hfe**
- **Diodes: Vf**
- **DC: 200uA, 2, 200mA, 20A**
- **Top quality rubber insulated probes/leads included.**

$159

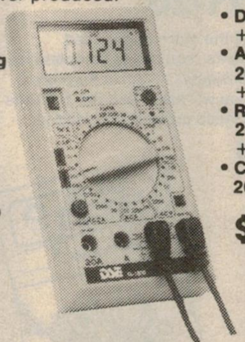


4.5 digit with Data Hold Function

What was the result? With most meters the reading is but a moment in time. If you miss it... The DSE Q-1600 solves the problem: hit the "data hold" button and the reading is frozen on the display! Another highly unusual feature is it's 20A range — double most meters. Add to that transistor and diode checking, capacitance, plus buzzer and LED continuity, and you have one of the most versatile meters ever produced.
Cat Q-1600

- **"Data Hold" function**
- **Up to 20A current reading**
- **Capacitance & transistors too**
- **Resistance: 200, 2k, 20k, 200k, 2M, 20M**
- **Capacitance: 2, 20, 200nF 2, 20uF**
- **Transistor Check: Hfe**
- **Continuity: Buzzer & LED**
- **Top quality rubber insulated leads included**

$225



Personal LCD with Auto Ranging

An amazing feature-packed 3.5 digit multimeter that's the size of a pocket calculator: only 10mm thick! Perfect for on-the-spot testing. It may be small but it boasts a number of impressive features. There's super-fast auto ranging, automatic polarity indication, 2 times/second sampling and audible continuity. Can even be used as a milli-volt meter (up to 20KHz).
Cat Q-1555

- **DC Voltage: 2000mV, 20, 200 400V +/−(2.0%rdg +/−2dgt).**
- **AC Voltage: 2000mV, 20, 200 400V +/−(3.0%rdg +/−5dgt).**
- **Resistance: 200, 2000, 20, 200k ohms +/−(2.0%rdg +/−2dgt)**
- **Continuity checks: 200 ohm +/−10ohm**

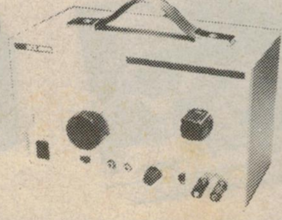
$49.95

'Pigeon Pair' AF Signal Generator

Square/Sine wave output audio signal generator, essential for work on huge range of circuits. With wide 20Hz-200kHz output and high accuracy, it is the perfect partner for the Q-1312 RF generator.
Cat Q-1310

- **Frequency range: 20Hz-200kHz**
- **Output control: High/Low unbal. (-20dB) and fine adjuster**
- **Sine wave output: 20Hz-20kHz, 5V rms max at 1% or less distortion**
- **Square wave o/p: 20Hz-20kHz, 10V p-p, 0.5us rise time**

$179



Wideband RF Signal Generator

Low cost RF signal generator that's ideal for the hobbyist/amateur as well as the serviceman. Great for checking tuners in AM, FM, and TV sets plus a huge range of general purpose service, troubleshooting and development work.
Cat Q-1312

- **Frequency range: 100kHz to 150MHz in six overlapping ranges**
- **RF output: 100mV rms approx (up to 35MHz)**
- **Modulation: 1kHz internal, 50Hz-20kHz external**
- **Audio output: 1kHz at 1V rms (fixed)**
- **Crystal oscillator: 1-15MHz external crystal, FR243 holder**

$179

KITS

FunWay 1 Gift Box

Makes an ideal birthday or Christmas present... and who knows, it could be the start of an absorbing lifetime hobby in electronics, or even an exciting career! Cat K-2605

24^{50}

FunWay 2 Gift Pack

Here's a gift bargain! Over $35 worth of value for less than $27! This gift pack has been specially selected for quality and for value. Cat K-2620

You get: • A copy of FunWay Volume 2 • A quality DSE Soldering Iron • A pack of solder • A 9 volt battery PLUS: A 'Wireless Microphone' Kit (kit 11) — by far our most popular FunWay kit!

26^{95}

FunWay 3 Bonus Pack

And what value! Buy this kit with two of the most popular kits in the FunWay 3 Book... and we throw the book in **FREE!** Yes, you get the Electronic Cricket project plus the Miniature Amplifier project — and as a bonus, the FunWay 3 Book itself at no extra charge!
Cat K-2670

29^{95}

FunWay Jumbo Gift Box

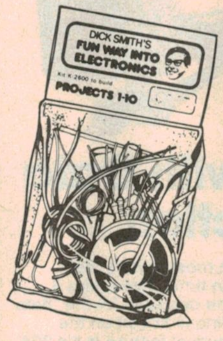
This pack isn't called the Jumbo pack for nothing: it's chocka-bloc with over 30 projects and a quality soldering iron to build them all. This may be the best gift a parent can give. Cat K-2690

98^{95}

FunWay 1 Project Kit 1-10

Enables you to build any of the first 10 projects in FunWay 1. And because the components are not soldered, they are all reusable so you can build any other of the first 10 projects, too! Cat K-2600

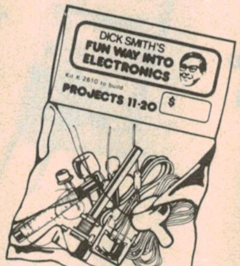
8^{95}



FunWay Project Kit 11-20

Contains the more specialised components required to complete the last 10 projects (11-20) in FunWay 1. NOTE: you will also need the 1-10 kits to build these projects. Cat K-2610

9^{95}



FunWay 1, 2 & 3 Gift Box

The pack contains all three books and a selection of the most popular and stimulating projects from each. Build a Flashing Brooch, Wireless Microphone, Cricket and Mini Amplifier plus much more! Cat K-2680

54^{95}

Binary Bingo

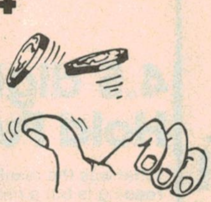
A great school project: it's a fun game — but even more it demonstrates binary numbers very well. And they're the basis of all computers! It seems pretty simple to play... but try it!
Cat K-2668

7^{95}

Two Up

Australia's 'national game' has finally been converted to electronics. Simulates the throw, the spin and the final result. Come in spinner! Cat K-2661

4^{95}



Soundbender

With this great little kit you can sound like a Dalek, Darth Vader, a Cylon or any one of a dozen robotic spin-offs! A versatile unit, it may also be used for special effects on electric guitars and other musical equipment. Cat K-3509

37^{95}

Lamp Saver

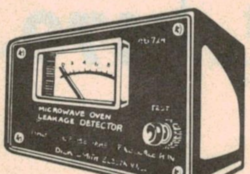
What a great idea! The DSE Lampsaver Kit will greatly extend the life of any 240V AC incandescent lamp. Those expensive Edison-screw spotlamps, etc can cost you a fortune when you have to replace them — but now, Lampsaver is here! The simple, money saving circuitry fits neatly behind your wall switch. Cat K-3083

14^{95}

Microwave Leakage Detector

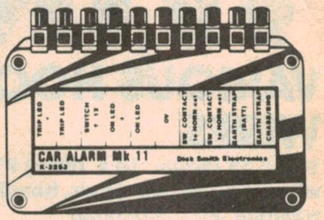
Microwave ovens are fantastic — but are they completely safe? Your's could be leaking dangerous radiation! Check it out with this handy meter. No batteries required. Cat K-3095

17^{45}



Car Alarm Mk 2

Includes die-cast case & terminal block



One of the most sophisticated, yet simple alarms around. It uses a triggering technique which makes it less prone to false alarms — yet it will sense a voltage drop anywhere in the electrical system. Cat K-3253

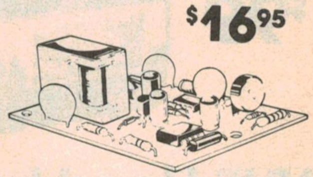
35^{50}

Economy Car Alarm

Low cost protection!

This alarm senses the voltage drop in your car's electrical system when a thief breaks into it. There's a visual warning for thieves so that chances are they will not even attempt a break-in. Cat K-3250

16^{95}



Ignition Killer

Ingenious but simple circuit based on a 555 timer that literally kills you car ignition. Making the thief think something is wrong with the engine. The theory is he'll then go and pinch someone else's car instead. Cat K-3255

22^{95}

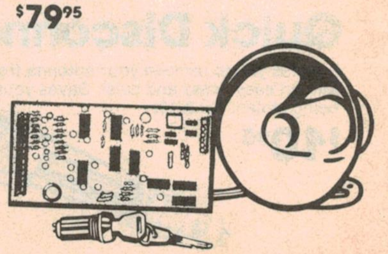
Deluxe Car Alarm

Here's what it offers:

- Two delayed and six instant alarm inputs
- Delayed entry and exit times (10s each)
- Provision for auxiliary battery
- Siren output (in case vehicle horn is disabled)
- Flashing dash lamp, internal key operated on/off, etc

Cheap insurance for your vehicle!
Cat K-3252

79^{95}



Splashout!

Seaphone

Beats a car phone by a nautical mile

The ultimate in marine communications — the MC 480 from Uniden. The 55 Channel VHF Marine Transceiver which allows you to link up to the normal telephone line while you're at sea. Just imagine — you can call home and ask for the chicken to be put on. The heavy duty plastic case is the ideal corrosion inhibitor. Incorporating the full 55 marine channels, PTT mic., 1W/25W selector, channel 16 emergency selector and indicator, bright LED digital channel readout, dim control, squelch and all mounting hardware. Cat D-1400

$469

Beat Corrosion

Give corrosion a bunch-a-fives; before it's too late! The amazing Cortec 101 corrosion inhibitor protects your valuable equipment. Simply slip the Cortec 101 into your electronic devices and an invisible vapour beats the hell outa those nasty little rust bugs. Lasts up to two years!! Cat D-1300

Was $5.95 **$4.95**

VHF Marine Whip Antenna

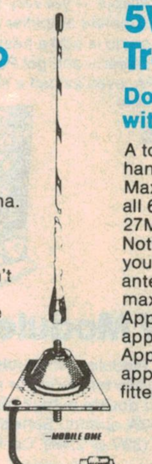
You won't beat this one for performance! Quality antenna which comes complete with heavy duty base and mounting hardware for VHF Marine use. Solid flat ground plate makes it easy to fit and keeps it stable when things get a little rough. Cat D-4016

$79.95

27MHz Helical: no ground plane required

Marine Helical Antenna. Now! A whip antenna for glass, wood and cement boats. This helical antenna doesn't need a ground plane. Helical whip complete with mounting base, cable and simulated ground plane. Great value when you're on the receiving end! Cat D-4070

$59.95

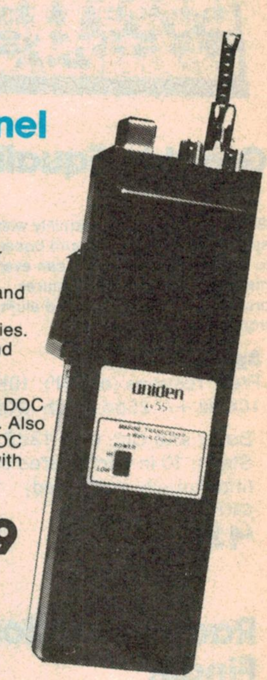


5W 6 Channel Transceiver

Don't leave shore without one!

A top quality high power hand-held from Uniden. Maximum legal power, and all 6 channels fitted with 27MHz marine frequencies. Nothing more to buy! And you can connect a boat antenna and power for maximum performance! DOC Approval No: 242M0172. Also approved for CB use (DOC Approval No. 249A022 with appropriate CB crystals fitted). Cat D-1125

$199



'Sea Simba' 27MHz Marine

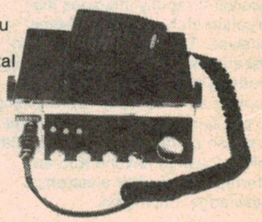
A truly advanced 12 Channel (10 fitted) Marine Transceiver! Advanced circuitry, advanced design, advanced ease of operation. The Sea Simba won't leave you floundering! You get all 27MHz marine channels, PTT mic, large LED channel indicator, ANL switch, PA, LED level indicators, squelch control, mic gain control, RF gain control, etc. and PA jacks, wiring harness and in-line fuse and mounting bracket. Cat D-1718

$139.95

Greater Range with AM/SSB

Trust Uniden to come up with the best! SSB for greater range and more efficient communications. When you're out at sea you don't want to take any chances! All 27MHz channels, S/RF meter, squelch control, digital channel display, RF gain, TX indicator and much more! And it's all packed into a new slimline design — so it looks as good as it performs. Cat D-1715

$299



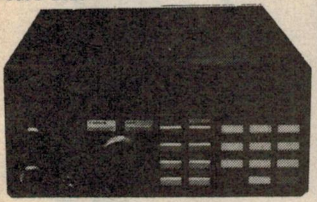
DICK SMITH ELECTRONICS PTY LTD

Any sailor worth his salt $aves at DSE!

KEEPING AMATEURS IN TOUCH!

The Magnificent... Yaesu FRG-9600

All receivers should be built this way — but then, Yaesu know how to build the best! The FRG-9600 is THE all mode VHF/UHF Receiver for the serious minded amateur. Covers the complete 60-905MHz spectrum with manual or f 'y automatic scanning — the choice is yours! FM M, CW, SSB... it's all there. For more features and better value, you can't go past DSE and Yaesu!
Cat D-2825



$1199

General Coverage FRG-8800

With an 8 bit microprocessor controlling all the tuning, mode selection, scanning, memory and clock functions you know the FRG-8800 can give you all the versatility you're ever likely to want. Covers the entire 150kHz-29.999MHz range PLUS it has inbuilt provision for VHF converter. Features 12 internal mem es, keypad, dial or automatic tuning, all mode/s lectable IF-BW... just about everything a general coverage receiver can have!
Cat D-2820

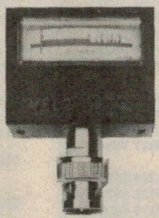
FRG-8800 DC kit Cat D-2822 FREE with purchase of D-2820 — value $8.75

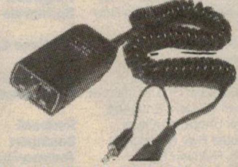
$1259

The Complete Amateur Station

For the amateur who wants everything in a transceiver — Yaesu developed the FT767GX. You want all bands? With 767 — you've got it! From 160 metres to 70 centimetres. Want that again? Yes, 1.8 to 440MHz in one transceiver. You don't know what features are till you've seen the 767 and once you've seen it — you'll own it!
Cat D-2935

At selected branches only $4995





The Best Test

The Oskerblock SWR-145 keeps you up to date! Designed to be left 'in-situ' for permanent readings. With a top range on two metres of 250 watts and, for VHF users, it needs very low power for full scale readings!
Cat Q-1341

$99

Hand-held Power Meter.

Weltz quality, the ultimate versatility and DSE value! Check the output of your hand-held accurately — just connect the TP-05X in place of your antenna and you've got it! 50-500MHz. Cat Q-1343

FREE with any VHF hand-held set

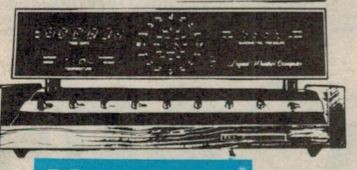
$29

Simple hands-free operation

Give your FT-2700RH or your FT-270/RH virtual hands-free convenience with the SB-10PTT Switch Unit. Use with optional headset/boom mic etc.
Cat D-3519

$39.95

"We all know that the world's best selling Electronics Kits are from Heathkit..." Jack O'Donnell — M.D. Altronics. Thanks Jack: you're right of course.



Heathkit

The Weather Detector!

The Digital Weather Computer displays everything from wind chill factor to indoor/outdoor temperatures, to wind speed and direction with accurate 16-point compass resolution. It even has microprocessor controlled memory for data storage by date and time! But what's best is; You can build it yourself! Cat G-2000

$995

The best in the land — DSE KITS

UHF 40 Channel Transceiver $249

With the DSE Explorer 70cm needn't be out of your reach! For a fraction of the cost of commercial models you too can be out there on the air waves. It's not a beginners kit — but then it's not a beginners sport!
Cat K-6300

UHF 80 Channel Upgrade $12.95

Add another 40 channels in the band from 439-440MHz to your DSE Explorer. This simple circuit gives the Explorer extended coverage of the UHF FM Amateur Band. Simple and incredibly inexpensive! Cat K-6301

50 watt UHF Power Amp $279

This amazing kit will lift a 2 watt output rig to the 50 watt level! Use it with CW, FM and SSB modes. Features 10MHz bandwidth, harmonics better than -60dB, 12 volt operation for mobile or home use AND DSE value!
Cat K-6307

VHF Amateur Transceiver $199

Save a fortune and get yourself a quality VHF transceiver into the bargain! The DSE Commander covers the full 144-148MHz band in 10kHz channels with 5kHz offset and has full repeater facilities built-in. Comes with everything you need to get it up and running.
Cat K-6308

UHF Gasfet Preamp $89

Give your 70cm a real boost in the reception department! For the 430-480MHz bandwidth you couldn't ask for a better kick in the butt. Ideal for both UHF CB and UHF amateur use! Easy to build and even easier to install.
Cat K-6309

2m Linear Amp $249

For the serious VHF DX'er here's a superb all mode high powered linear amplifier which will give you that access to the distant repeater! Suitable for both mobile and base operation. Designed for reliability! Cat K-6313

- **Frequency coverage: 144- 148MHz**
- **Maximum output: 120W (CW) for 15W input**

VHF Wattmeter $52.95

This could save you a fortune! Get the most from your equipment. The VHF Wattmeter measures the VHF power output and the efficiency of your antenna system by measuring the reflected power from your antenna. Cat K-6316

- **Useable Frequency Range: 144-148MHz**
- **Maximum Power: 150 watts**
- **Ranges: 0-150 watts, 0-30 watts**

DICK SMITH ELECTRONICS PTY LTD

Who gives the best price on Amateur gear? — DSE of course!

What's new in PC boards

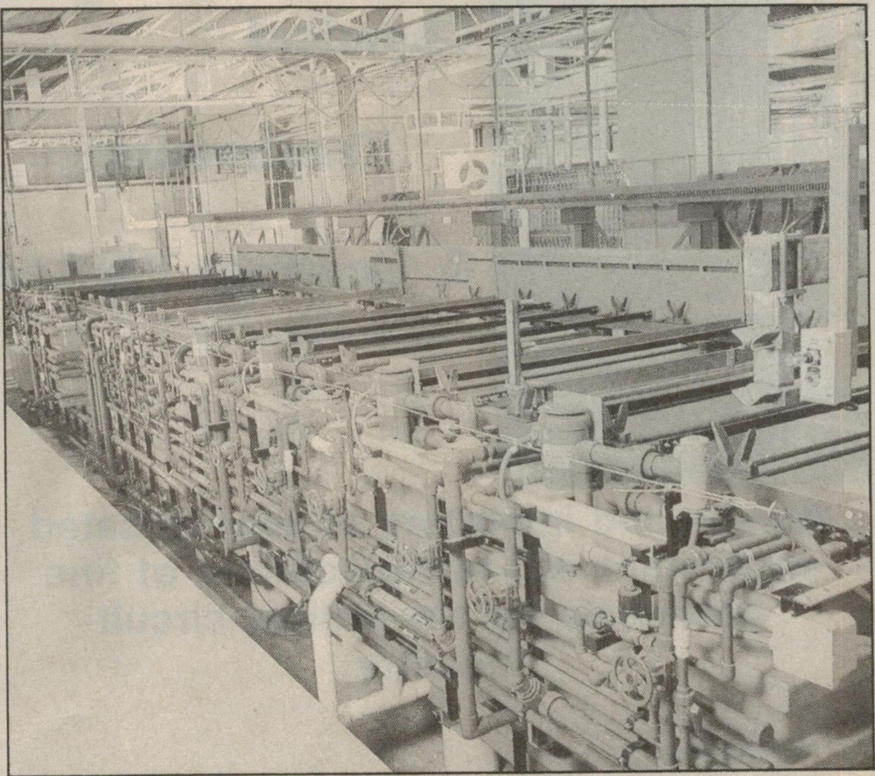
Virtually every unit of electronic equipment has a printed circuit board. Some are very complex, as in computers and defence equipment, while others are quite simple and accommodate only a few components. Either way, the design and manufacture of the printed circuit board has become one of the most crucial aspects of the electronics industry.

by LEO SIMPSON

At one time, the printed circuit board was regarded as merely a convenient way of making circuit interconnections between many components. It replaced point-to-point wiring in valve equipment and was a necessity right from the beginning of solid state circuitry.

Over the years though, the printed circuit board has evolved and been refined to the point where the resources applied to the design and manufacture of the PCB in most electronic equipment is a major part of the total investment. As components have evolved from discrete semiconductors to integrated circuits of ever-increasing complexity, so have printed circuit boards.

Originally, all circuit boards were single sided only, with components on one side and copper tracks on the other. Then came double-sided boards, with most of the tracks on one side, and additional tracks and perhaps a "ground plane" on the other. Double-sided boards are used both with densely packed logic circuitry such as computer memory, or with analog circuitry, particularly RF circuitry where ground



A modern PC plant has a big investment in processing plant as this view of the new process line at Teknis Pty Ltd shows.

This is a vacuum exposure table where UV light transfers the image of the PC pattern onto the photosensitised copper laminate.

planes can be important to ensure high performance.

Multilayer boards

In recent years, as VLSI circuits have become more widely applied, boards with four and more layers have become commonplace. Typically, a four-layer board will have tracks on both top and bottom and the inner conductive layers will be for the positive and negative supply lines.

Depending on which manufacturer you talk to, the number of layers in a multi-layer board can be as many as 24 or more. Such complex boards are difficult to manufacture, have a great many production steps and as a result, may cost hundreds or even thousands of dollars each.

The overriding reason why multi-layer boards have become commonplace is that there is a continuing requirement on the part of circuit designers to increase component packing density. Even with very thin tracks there is still a limit on the number of tracks up the centre of a typical 16-pin IC package and for the moment, it is only possible to run one track between adjacent IC pins.

Therefore, if ICs are to be closely packed together, the only way to make all the interconnections between them is to have conductors in two or more layers. Typically, the use of a multi-layer board will enable the circuit packing density to be doubled over that which can be achieved with a double-sided board.

Design techniques

Today, some multilayer boards used in defence equipment may have as many as 4000 pin-through connections and accommodate hundreds of surface-mount ICs on an area half the size of one page of this magazine. Clearly, such boards pose a monumental task for the designer and it may take many months or man-years to produce a final version. Luckily, the computer has come to the rescue here and there are now quite a few CAD (computer aided design) software packages for the production of final artwork.

Such aids are essential if the PCB design is to be produced within a reasonable (and competitive) time although they are not the whole answer. There are many tricks to the trade, so much so that a number of CAD bureaus have sprung up to satisfy the demand for specialised printed circuit board design. One such bureau is RCS Design Pty Ltd, of 728 Heidelberg Road, Alphington, Victoria 3078. Phone (03) 49 6404.

VISTA VX

Screen image inspection.

The ultimate inspection equipment and a worthy successor to our proven Vista and Vista 5. VISTA VX is a superb screen image offering variable magnification and direct access to the workpiece. Features are a progressive 5 to 10 x magnification with an excellent image and an especially good field of view and independent top and underboard lighting. VISTA VX is the only choice for PCB's, artwork, SMD's and solder joint inspection.

Made in England by Plessey Controls Ltd. and distributed in Australia by:

WS32

Westinghouse Systems

Vic: 80-86 Douglas Pde., Williamstown, Vic.
(P.O. Box 267 Williamstown Vic. 3016.)
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TENNYSON GRAPHICS

Tennyson Graphics can do your photoplotting with the speed of light.

Tennyson Graphics are Australia's only company with state of the art laser photoplotting and computer graphics.

So we can photoplot artwork masters of your printed circuit boards with higher speed, higher resolution and higher accuracy than anywhere else in the country.

You can even choose your own non standard apertures on our Scitex Response 280 System. It can also do step-and-repeat and nesting up to 1000 mm × 1850 mm.

And of course we can accept data on tape or floppy disk in industry standard Gerber format.

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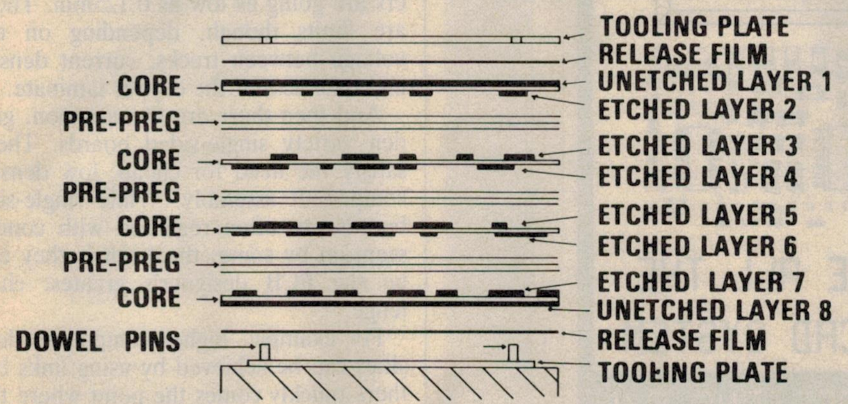
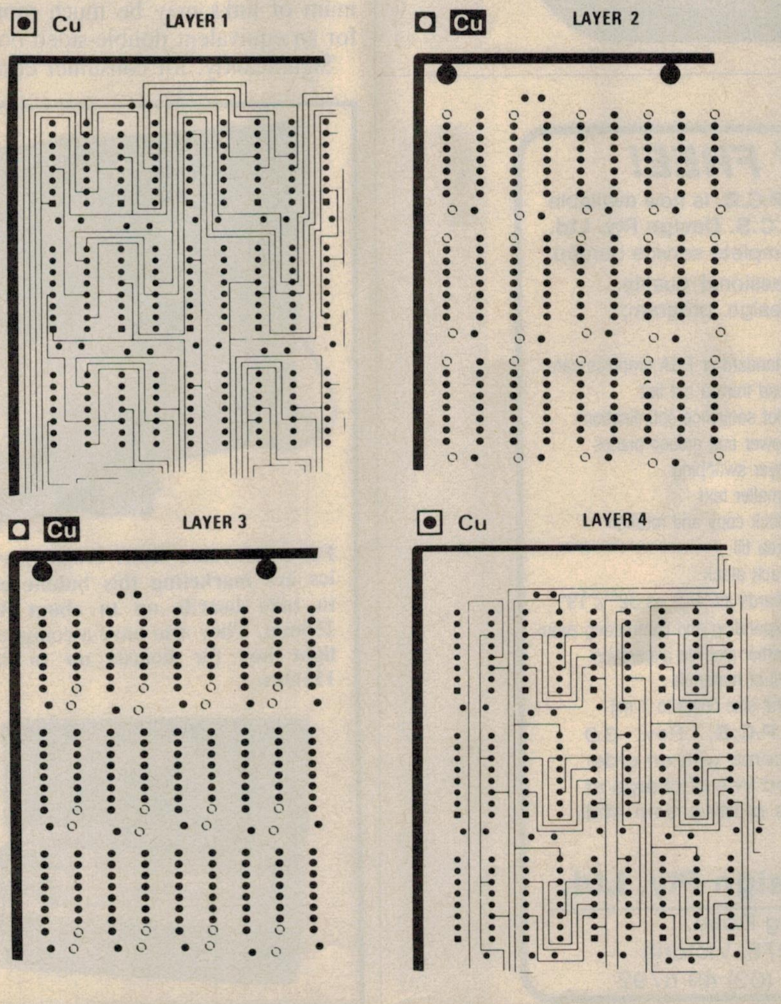
Such bureaus have considerable experience in the use of CAD software and in the design of complex boards generally and so are able to produce a final design much more quickly than an engineer in a small firm who may only produce one or two new products a year. Some bureaus can also be of considerable assistance in the production of prototype boards for proving of designs. Wirewrap or multi-wire boards are often used for this purpose.

According to Ray Smith of RCS Design Pty Ltd, multi-layer, double-sided and single-sided boards all have particular advantages, depending on the application. Although multi-layer boards are expensive, their design is often greatly



This diagram shows the makeup of a typical multilayer board while below is the artwork for a four-layer board. Note that the two ground planes are in negative form. Diagrams by courtesy of Morris Productions Pty Ltd.



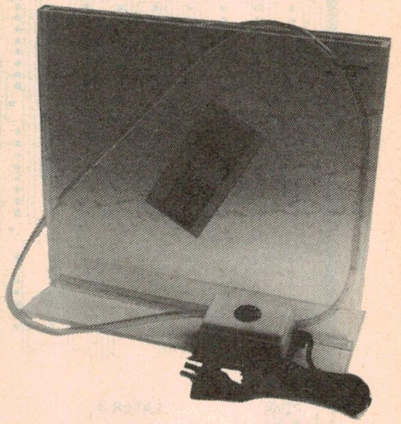
simplified compared with a double-sided board of similar component density.

Double-sided boards are the most common in todays's computer and communications equipment and the use of very fine tracks and small pads (for lead connections) is allowing higher component densities. Run-of-the-mill boards these days are using track widths and spacing of 0.2mm and some manufacturers are going as low as 0.125mm. There are limits though, depending on the voltage between tracks, current density and thickness of the copper laminate.

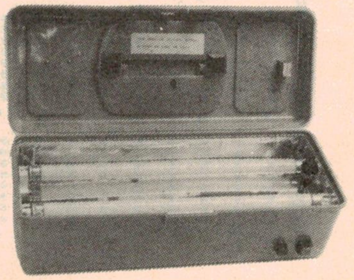
And then there are the common, garden variety single-sided boards. These satisfy the need for cheap, low density component assembly. While single-side boards are often regarded with condescension by some, the truth is they can be the PCB designer's greatest challenge.

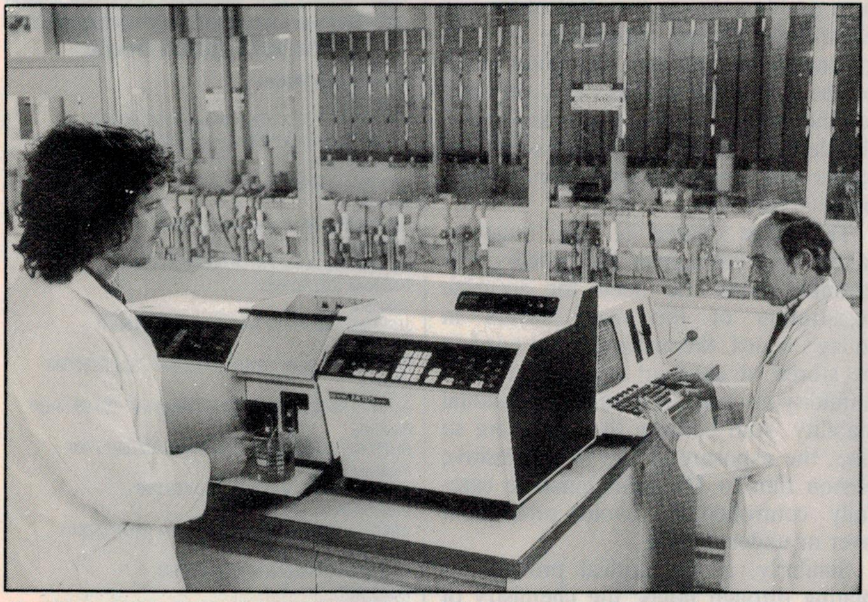
For example, higher component densities can be achieved by using links but there quickly comes the point where the cost of insertion of links may be greater than the cost of a double-sided board. And the design time necessary to produce a single-sided board with a minimum of links may be much more than for an equivalent double-sided board.

Significantly, for consumer equipment



For small runs, Geoff Wood Electronics are marketing this bubble etcher to take boards up to about 300 x 250mm. They also have a compact UV light box for boards up to 230 x 115mm.





Precise control of chemistry in the etching and plating stages of PCB production is essential. This facility at Teknis Pty Ltd includes an atomic adsorption spectrophotometer.

with large production runs, the single-sided board is king. Have a look inside Japanese video and hifi equipment. Virtually all of it uses single sided boards with lots of links.

Besides increasing component density, links also allow a board to be adapted to produce a number of variants of a basic design. This can be important both for consumer equipment which has large production runs, and for more specialised equipment where the production runs may be very small.

Power dissipation

Apart from the type of board selected, there are many factors which determine the final cost of the product. Most are electrical and mechanical considerations. For example, power dissipation of components must be considered in deciding their placement and orientation, and how close they can be to other sensitive parts of the circuit.

Along the same lines, wirewound or carbon film resistors can radiate a considerable magnetic field which can induce voltages into other parts of the circuit and thus cause crosstalk and distortion. With high component densities, this can be a problem for both analog and digital circuitry. This may require the use of shielding and guard electrodes in some cases.

With the trend to very small pads and clearances, the intended soldering technique must also be considered at the outset. This is because the use of very small pads can have a big effect on component solderability.

At the same time, the problems of power dissipation and component placement are magnified when another recent development is considered: surface mount devices. These components are so small that they require a major rethink on the part of electronics designers and manufacturers.

Surface mount devices

SMDs lend themselves equally well to use on single-sided, double-sided and multilayer boards. On the single-sided boards they can be used together with conventional components, most often with passive surface mount resistors and capacitors on the underside and conventional semiconductors and ICs on the topside.

On double-sided and multilayer boards, SMDs can be used on both sides, giving a major increase in component packing density. Where the rethink is required is in the consideration of the power dissipated by surface mount components. For conventionally sized components such as resistors, diodes, and transistors, most of the power is dissipated by the component leads and body with the rest of the power being conducted away by the associated tracks on the printed circuit board.

For surface mounted components this relationship is reversed. Since the component bodies are so small and they have no leads, virtually all the power dissipation is conducted away via the PC tracks. That raises two problems.

First, the relevant PC tracks must be thick enough to efficiently conduct the heat away and second, semiconductors must be located so that heat from other components is not conducted directly into sensitive junctions.

All the foregoing indicates that there are a lot of practical factors to be considered when designing today's printed circuit boards, apart from the requirement to meet Australian and overseas standards, defence or otherwise.

Board manufacture

If designers have to look to their laurels, so too must board manufacturers. With the large number of production steps involved in double-sided and multi-layer boards, even quite good production controls can still lead to unacceptable reject rates.

For a typical double-sided board, there may be as many as 14 key stages in production. If each stage has a pass rate of 99.5% the resulting overall reject rate is 7% which is clearly too high. Extending the same thought to multilayer boards indicates that great care must be taken at each production stage if overall yield is to be satisfactory.

This attention to detail starts right at the beginning, when the production quotes and estimates of delivery time are prepared. It is at this stage that the client's PCB artwork must be appraised, not only to determine the overall cost but to ensure that stated quality standards can be met.

Examination of the artwork may also indicate where production problems may arise. For example, a double-sided board with plated through holes and a large area of ground plane may prove to be a problem during the electrolytic and electroless plating processes — the ground plane may take the lion's share of the copper deposited. This problem for the manufacturers can be avoided if the designer elects to use cross-hatched rather than solid copper for ground plane areas.

The same degree of care must be taken right throughout the process. For example, with the need for accurate registration of the many layers in today's board, the artwork films need to be stored at constant temperature and humidity in order to ensure dimensional stability. And because the tracks are so fine, the exposure of the photosensitive Riston film to UV light must be carefully controlled to avoid subsequent over or under-etching.

Similarly, in the critical process for plating through holes, the chemistry of the electroless and electrolytic plating baths must be controlled to very tight limits.

It all adds up to a considerable investment in training of personnel and capital equipment to ensure that the final product is up to world standard. It is certainly a far cry from the simple printed boards of several decades ago.

When all is said and done though, the Australian printed circuit board industry is alive and growing strongly and should continue to increase its share of the total Australian market.

We gratefully acknowledge assistance from the following companies in the preparation of this article: Morris Productions Pty Ltd, East Coast Printed Circuit Boards Pty Ltd, Teknis Ltd, RCS Designs Pty Ltd.

Another big investment for PCB manufacturers involves the numerically controlled high speed drilling machines. Photo courtesy of Teknis Pty Ltd.

Some of the mind-numbing technical details that conclusively prove why Sony ES compact disc players are second to none.

Our engineers were last seen doing somersaults.

No doubt they're more than pleased about developing the world's best compact disc players.

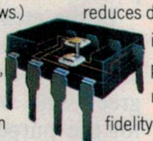
The Sony ES Series.

But they became ecstatic when we asked to borrow the technical manual.

Instead of resorting to tiresome adjectives, we thought it best to substantiate this bold, much bandied-about claim.

With facts and proof, and lots of it.

Sony's state-of-the-art technology will take some explaining. (Although what state you'll be in after reading it all, who knows.)



For the purposes of flow and to minimise the risk of repeating ourselves, the words breathtaking, staggering and mind-boggling have been edited from the original technical report where they occurred no fewer than 174 times.

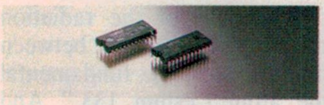
(Much to our engineers' dismay, we're currently editing all superlatives from the ES Series amplifier, tuner, cassette deck, speakers, graphic equaliser and surround-sound-decoder technical manuals.)

Naturally, not all features are available on some models.

The Digital to Analog Converters. A true test of your powers of concentration.

Not one, but two Digital to Analog Converters are used for each independent channel to obtain accurate sound separation.

(Buy one, get one free!)



NOT ONE BUT TWO D/A C's.

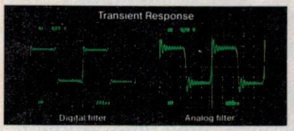
Together with twin monaural construction, the result is the best sound quality available in the world today.

That's being modest, of course.

Now, the way these little devils work is pretty obvious once you know how.

(This next bit is really dry, so we suggest you grab yourself a glass of water.)

The serial data recorded on a CD cannot be simultaneously reproduced into



A COMPLICATED GRAPH.

L-channel and R-channel audio by a single D/A Converter no matter how hard it tries, creating a slight time-lag between the left and right channels.

Although this time-lag can hardly be sensed by the human ear, we eliminated it anyway.

Theoretically speaking.

By adopting independent D/A C's for L- and R-channel, the signal of both channels is converted simultaneously.

Which simply means, of course, that sound from both the left and right speakers reaches the listener at the same time.

Obvious. Isn't it?

The Optical Transfer System will bring tears to your eyes.

By incorporating an Optical Transfer System for music signal transfer from the Digital Circuit to the D/A Converter, digital noise is prevented from entering the analog circuits. Thus, clear sound is maintained.

In other words, Optical-Transfer reduces distortion that causes harshness in the high frequencies, and produces a rich solid bass resulting in pure, clean high-fidelity sound, as they say in the technical manual.

A wireless Remote Commander for the chronically lazy.

The full function wireless Remote Commander allows total control of all major features including 20 key Direct Music Select.

Even line-out level control is possible without moving from your seat.

The only time you get up is to get a beer out of the fridge, but we're working on it.

The mechanics of the Linear Motor Tracking Mechanism.

Incorporated in this sophisticated unit is the Linear Motor Tracking Mechanism.

Instead of using gear linkages, the pick-up is mounted directly along a pair of rails.

It thus assures high reliability and ultra-quick access within one second.

The New Tracking Servo Control Circuit incorporates Envelope Differential Detection and Servo Voltage Hold circuits.

With this System, Error Signals Caused ...sorry, caused by dust, smears, etc., or defects in the disc itself, are detected and corrected at high-speed.

Before they cause tracking error.

Unstable tracking is detected at the input of tracking error voltage to the window comparator.

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z z z z z z z z z z z z z z z z z... oh... sorry... where were we... ah yes... well so much for the Servo Voltage Control circuit.

What a little marvel.

The Cerasin Chassis. Famous for its quick attenuation to vibration.

The new Cerasin chassis (Ceramic & Resin) is reinforced with ceramic outserts that absorb mechanical vibrations and unwanted resonance.

As you may have guessed, the main characteristic of the plastic resin with ceramic powder is its quick attenuation of vibration.

(Small ceramic particles are scattered amongst the plastic compound, causing friction between ceramic particles and the plastic, resulting in attenuation. Phew.)

Do the Harlem Shuffle with our Shuffle Play.

Use the Shuffle Play to automatically playback the entire disc in continuous random order.

Although no amount of shuffling will make a Burl Ives disc seem fresh.

A 20-key Direct Music Select function allows you to play your favourite selections anyway, anytime, even with one arm tied behind your back. And the RMS random programming system will memorise the playback order of up to 20 selections.

Use the Index Search or two-speed manual search with the AMS (Automatic Music Sensor) to play any particular selection.

Five repeat functions allow you to repeat one selection/all/A-B/RMS or Shuffle Play. Now the RMS comes with an additional memory back-up for convenient timer play.

The unique Unilinear Converter System. Try saying that five times fast.

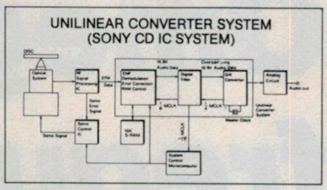
The Unilinear Converter System is the "heartbeat" of the player.

Operating from one masterclock, the EFM demodulator, Digital Filter and the D/A Converter are combined into a single synchronised system, eliminating beat noise jitter from the digital processing circuits.

THE CDP-502ES II.

The rhinoceros is a much misunderstood animal. (Don't worry. Just checking to see if you're still with us. Plough on.)

The 16 bit Digital Filter with 2 times oversampling and high-speed D/A C raises the noise component of the digital signal above 20KHz, allowing the use of a gentle slope Low Pass Filter to reduce distortion



and time-lag.

Have we converted you yet?

The Music Calendar & 6-mode time-keeper function. (Or the M.C.6-M.T.K.F.)

The large FL display has all of the information you need to know, the Music Calendar shows the number of selections on the disc or programmed. And a check-button gives instant confirmation of the program order. The selections are "checked off" as they are played.

The 6-mode Time Keeper function gives you complete time information of the total playing time and remaining time of the total disc, programmed selections, time elapsed and remaining time of the selection in play, time after time.

We've thrown in everything, including the oxygen-free copper heat sink.

Sony has loaded the ES series with more power than you need, to assure powerful bass sound reproduction.

This is thanks to the use of large capacitance power transformers, high-speed diodes and large filter capacitors.

Over-simplifying it, clean sound is enhanced by separating the power supplied from the digital and analog blocks so that interference is eliminated.

The audio circuitry uses noiseless carbon resistors that were especially designed for audio components.

THE SINK.

Non-inductive styrol condensers and ...um...palyprip... polypropylene film capacitors assure low distortion in the high-frequency range.

In addition, a non-magnetic Oxygen-Free Copper heat sink and copper screws are carefully selected.

If you want more information, please contact the Sony Technical Department.

And we'll refer you to a psychiatrist.

SONY®
THE LEADER IN DIGITAL AUDIO.

SSB(S)SNY 001

New reference gives cesium beam accuracy

Omega derived frequency standard

Over the past few decades, improved accuracy in the measurement of time and frequency has become increasingly important. Following on from our description of the simple temperature-controlled crystal oven, in the April 1987 issue of EA, we now present an Omega Derived Frequency Standard which is capable of providing a high degree of frequency accuracy and stability.

by IAN POGSON, VK2AZN

Time and frequency are two quantities which bear a direct reciprocal relationship to each other. The degree of accuracy with which they could be determined in the past was not good, to say the least. Even the definition of the second was not very precise. Prior to 1956, the second was defined as "one 86,400th part of the time required for an average rotation of the Earth on its axis with respect to the Sun."

However, due to external influences, such as the Moon and Sun, the Earth's rotation is somewhat irregular. Astronomers have long been aware that these irregularities existed and due allowance was made for them, where necessary.

In 1956, an international agreement was reached to define the second more precisely. This was called the "ephemeris" second and it is defined as 1/31,556,925.9747 of the time taken by the Earth to orbit the Sun during the tropical year 1900. This was a significant step. Unfortunately though, astronomers were not able to make observations with anything like this order of precision.

The new frequency standard provides five cesium-locked outputs at 1kHz, 10kHz, 100kHz, 1MHz and 10MHz.

In the meantime, research into atomic transitions showed that some related oscillations were stable to a very high degree. One which seemed to lend itself for the purpose of time measurement is a transition between two hyperfine levels in the Cesium atom. In 1964, the Twelfth General Conference on Weights and Measures held in Paris, defined the second thus: "The standard to be employed is the transition between two hyperfine levels F = 4, MF = 0 and F = 3, MF = 0 of the fundamental state 2S 1/2 of the atom of Cesium 133 undisturbed by external fields and the value 9,192,631,770 Hertz is assigned."

Again, in 1967, the 13th General Conference on Weights and Measures, held in Paris, issued a new phrasing of the definition of the second. It reads: "The second is the duration of 9,192,631,770 periods of the radiation corresponding to the transition between two hyperfine levels of the fundamental state of the atom Cesium 133." And that is where the definition of the second rests for the present.

Frequency may be defined as the number of events which take place during a specified interval of time. In electronics, the second is usually the specified time interval. Frequency used to be quoted as so many "cycles per second". This term has been set aside in favour of the term "Hertz", usually abbreviated Hz. This unit is multiplied where necessary, by a thousand to kilohertz, a million to megahertz and so on.

Measuring time past

Having defined time and frequency, let us look at the way these quantities were measured in the recent past. In 1920, the tuned LC circuit was the best available means and at the time this provided a stability of one part in 10^4. When converted into terms of time, it amounts to a possible variation of about nine seconds in a day.

The Omega System

The Omega navigation system is based on a global network of eight stations and is used by ships, submarines, aircraft and land vehicles. It is capable of providing a "fix" accurate to about 1km in daylight and about 2km at night.

Each station is equipped with four cesium beam frequency standards to ensure the highest possible accuracy. In addition, each station is monitored by the US Naval Observatory to ensure that the required precision is maintained.

Because of the accuracy of the transmitted frequencies, the Omega system may also be used as a frequency standard and for time-keeping. The accompanying chart (Fig.1) has been prepared by the author from available information and from his own observations and measurements. It shows the frequencies used by each of the eight stations during each 10 second period.

OMEGA VLF NETWORK FORMAT

(Frequencies in kHz)

	SEGMENT	A	B	C	D	E	F	G	H
	DURATION (SECONDS)	0.9	1.0	1.1	1.2	1.1	0.9	1.2	1.0
	STATION								
A	Bratland, Norway	10.2	13.6	11⅓	12.1	12.1	11.05	12.1	12.1
B	Monrovia, Liberia	12.0	10.2	13.6	11⅓	12.0	12.0	11.05	12.0
C	Oahu, Hawaii	11.8	11.8	10.2	13.6	11⅓	11.8	11.8	11.05
D	Lamoure, Nth. Dakota, U.S.	11.05	13.1	13.1	10.2	13.6	11⅓	13.1	13.1
E	La Reunion Is. Ind. Ocean	12.3	11.05	12.3	12.3	10.2	13.6	11⅓	12.3
F	Trelew, Argentina	12.9	12.9	11.05	12.9	12.9	10.2	13.6	11⅓
G	Sale, Vic., Australia	11⅓	13.0	13.0	11.05	13.0	13.0	10.2	13.6
H	Tsushima Is. off Japan	13.6	11⅓	12.8	12.8	11.05	12.8	12.8	10.2

0.2s

10 SECONDS

By 1923, the tuning fork provided a stability of one order of magnitude better, or one part in 10^5. Referred to a time basis again, this is better than one second in a day.

Also, in the 1920s, an Englishman named Shortt developed the now famous Shortt free-pendulum clock, which became a standard for time and frequency. This clock was installed in all the major observatories throughout the world and was the standard for time measurements until the beginning of World War II. As a result of the high performance of this clock, frequency could be ascertained to at least one part in 10^6.

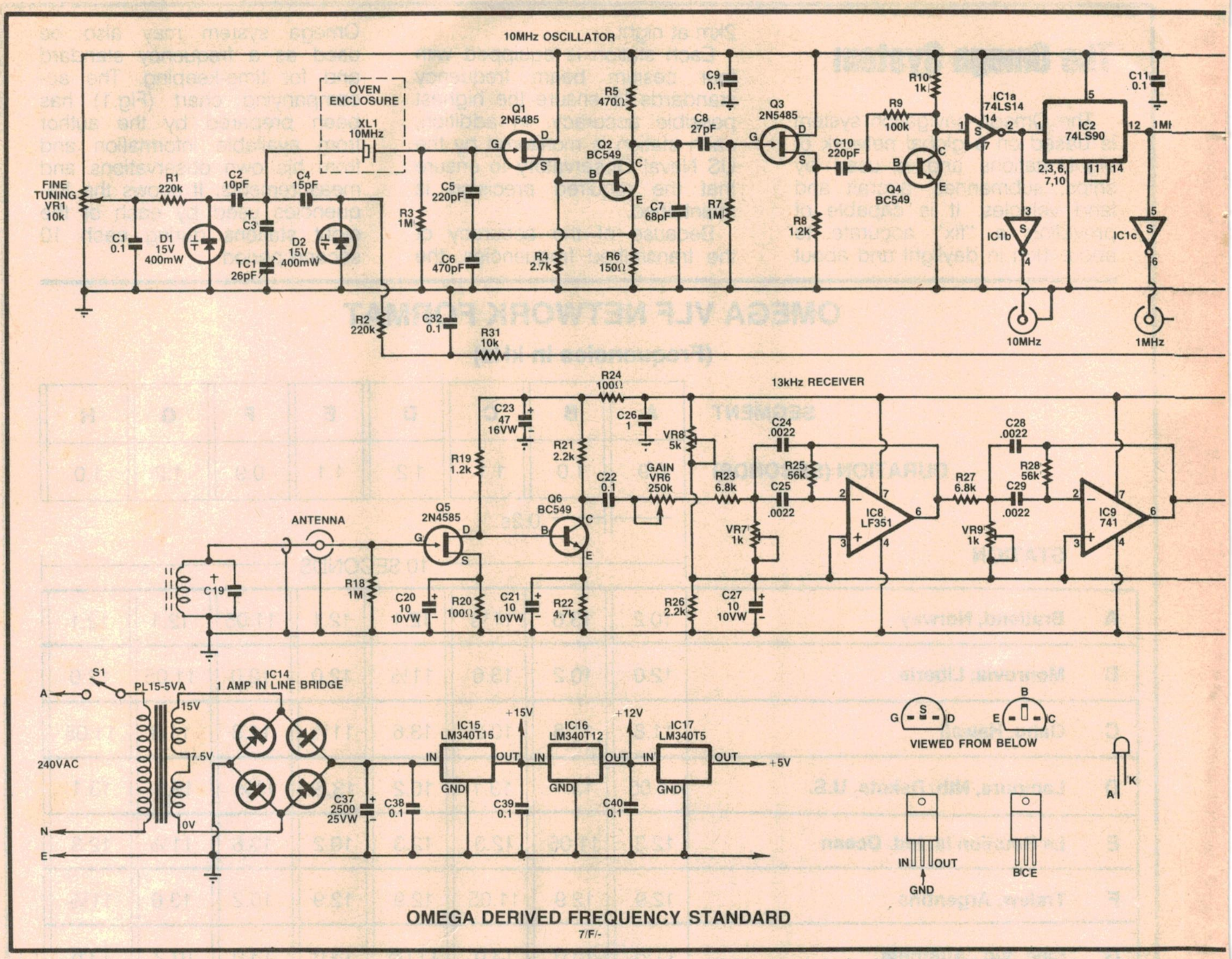
In the meantime, W.A. Marrison of the Bell Telephone Laboratories in New York was investigating the possibilities of using a quartz crystal oscillator for the purpose of accurate time-keeping. From Marrison's work around 1929 has evolved the now familiar crystal oscillators, widely used in all manner of electronic equipment. This step forward improved on the stability already achieved by the Shortt clock and the crystal reached a stability of the order of one part in 10^8 and well beyond in some cases.

Note, however, that typical crystal oscillators in most electronic equipment do not achieve anything like that order of accuracy or stability.

Cesium beam standard

The inexorable quest for still greater accuracy finally led to the realisation of the Cesium beam standard. At first, accuracies of the order of one part in 10^9 were achieved but as techniques improved, this figure was left far behind and now parts in 10^{11} and 10^{12} are commonly achieved. Indeed, in large laboratory standards, such as the National Bureau of Standards in the United States, a few parts in 10^{13} are quoted.

All this does not mean that we all want or need to measure frequency and time with such high orders of accuracy. But there are many circumstances where it is desirable to be able to measure frequency with an accuracy at least as good or better than the resolution of typical frequency counters. For example, if you have an 8-digit frequency meter, it is desirable to have a timebase which is accurate to within one part in 10^9.



The circuit uses a phase comparator to compare the 13kHz Omega signal with a 13kHz signal derived from a 10MHz crystal oscillator. The resulting error voltage is then used to correct the oscillator.

With this concept in mind, we have produced the Omega Derived Frequency Standard. Its immediate application is as a timebase for frequency counters and frequency synthesisers. It could also be used as the basis for a very accurate clock.

Time standards in Australia

Unfortunately, Australia is not well endowed with standard time and frequency facilities. The notable exception is the HF transmission of VNG in Lyndhurst, Victoria. This source does a fine job but HF transmissions do have their limitations.

There have also been reports that VNG may be closed down in the foreseeable future. If this should occur, it would be quite seriously missed. On the other hand, we do have Omega and it is on this transmission that we have based our new frequency standard.

The standard has been checked and found to have a stability approaching a few parts in 10^{10} with the proviso that signal conditions can fluctuate in the hours of darkness, and especially at sunrise and sunset. The moral of this is that for really accurate measurements, the Frequency Standard needs to be used during daylight hours.

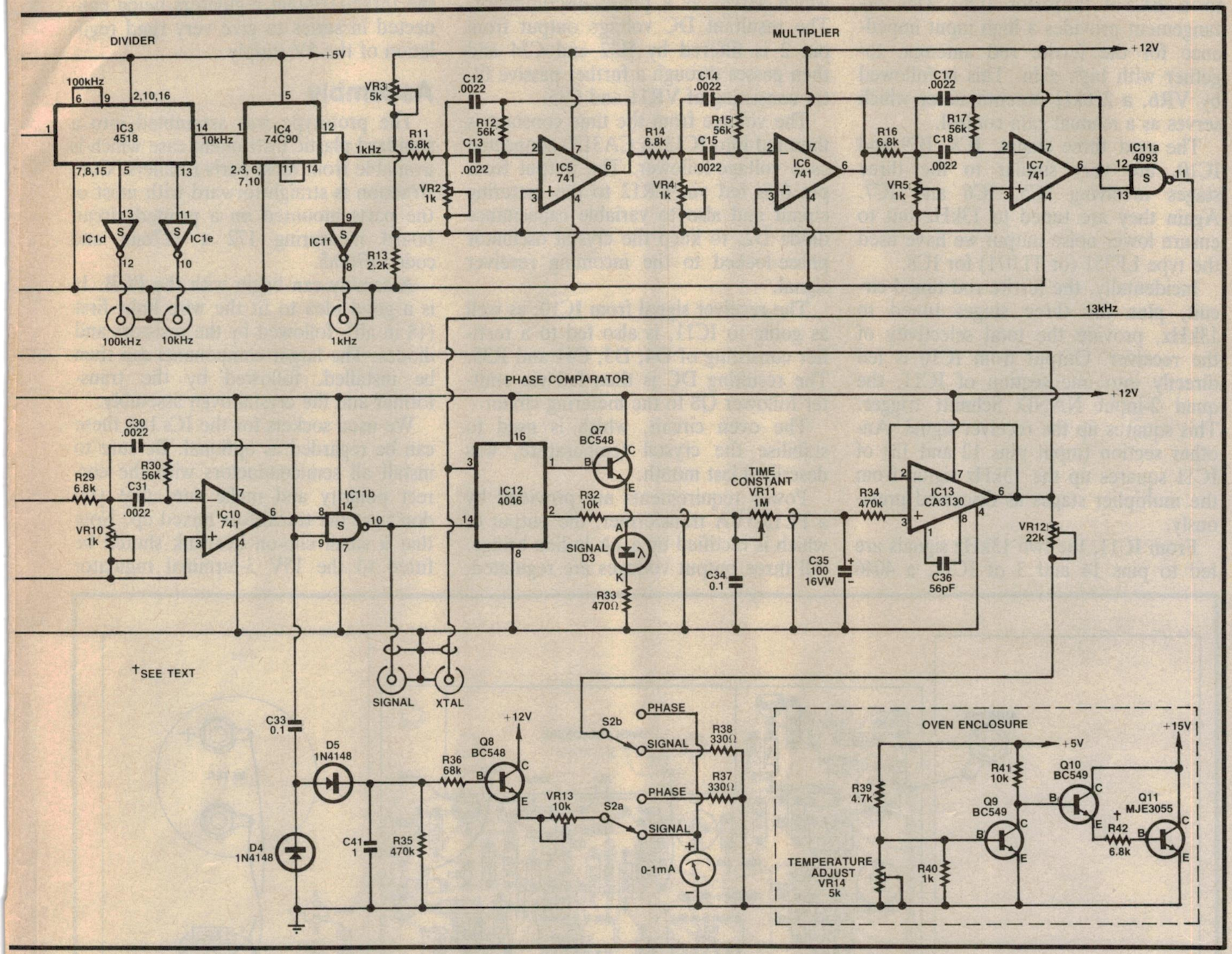
Circuit description

Let us now discuss the circuit. Essentially, the whole circuit is a phase lock loop. It comprises a 10MHz oscillator which is fed to a series of decade dividers to produce 1kHz, a multiplier circuit to produce 13kHz, and a receiver to pick up the 13kHz signal from the Omega transmitting station (near Sale in Victoria). A phase comparator is used to compare the two 13kHz signals and the resulting error voltage is used to correct the 10MHz crystal oscillator and thus ensure very high stability and accuracy.

The 10MHz crystal oscillator is a Colpitts configuration with a 2N5485 junction field effect transistor, Q1, direct coupled to a BC549 bipolar transistor, Q2. This combination provides a high input impedance together with high gain. It also enables the use of high-value feedback capacitors, C5 and C6, which makes for higher frequency stability than would otherwise be the case.

The 10MHz crystal itself is installed in the temperature controlled oven referred to previously. Coarse frequency adjustment is provided by a 26pF variable trimmer (TC1), connected in series with the crystal via C3 which will be mentioned later.

Fine frequency adjustment is achieved with a variable capacitance diode (D1) in series with a 10pF limiting fixed ca-



pacitor (C2). Reverse bias on the diode is applied from a 10kΩ multiturn trimpot, VR1, across the 5V supply rail.

A third means of varying the crystal oscillator frequency is by a second variable capacitance diode (D2) in series with a 15pF limiting fixed capacitor (C4). Bias derived from the phase comparator is the means whereby the crystal oscillator frequency is phase-locked to the incoming 13kHz signal, as mentioned above.

Incidentally, we have used 15V 400mW zener diodes for the varicap diodes. These do the job very satisfactorily and are considerably cheaper than the "real" ones!

The crystal oscillator is followed by another 2N5485 JFET (Q3) configured as a source follower. This gives a measure of isolation between the oscillator and following circuits. Note that a relatively large resistance has been included in the source of each of the JFETs. This helps to reduce the effect of supply voltage variations on the frequency of oscillation, by virtue of negative feedback effect. Although the supply voltage is rigidly regulated, all these precautions make for a very stable oscillator.

The next stage is a BC549 transistor (Q4) used as an interface for the logic circuitry which follows. One section of a 74LS14 hex Schmitt trigger (IC1) serves as a buffer between Q4 and a 74LS90 (IC2), which divides the oscillator signal down to 1MHz. This is then divided down successively to 100kHz and 10kHz by IC3, a 4518 dual decade counter.

Finally, the 10kHz signal is fed to IC4, a 74C90 decade divider to produce 1kHz. All of these frequencies are brought out to the front panel sockets via the remaining sections of IC1, which serve as output buffers.

13kHz multiplier

Because the signal we receive from Omega is at 13kHz, it is necessary to derive 13kHz from the crystal oscillator, so that we may compare it with the incoming signal in the phase comparator circuit. This presents a problem, in that the only way which we can obtain this frequency is to multiply up from the already divided down 1kHz.

There are several ways of doing this but the method chosen here has been to amplify the 13th harmonic of the 1kHz signal. This is achieved by three active filter-amplifiers (IC5, IC6 and IC7), each using the ubiquitous 741 operational amplifier. Each stage is tuned to 13kHz by means of a 1kΩ trimpot.

The 13kHz sinewave output from IC7 is then fed to one section of IC11, a 4093 quad two-input NAND Schmitt trigger to improve the wave shape. From here it is fed to the signal input of IC12, a 4046 used as a phase comparator, otherwise known as a discriminator.

Receiver circuitry

The first stage of the receiver consists of a 2N5485 JFET (Q5) direct coupled

to a BC549 transistor (Q6) This arrangement provides a high input impedance for the ferrite rod antenna, together with high gain. This is followed by VR6, a 250kΩ potentiometer which serves as a manual gain control.

The next three stages, IC8, IC9 and IC10, are very similar to the three stages involving IC5, IC6 and IC7. Again they are tuned to 13kHz but to ensure lower noise output we have used the type LF351 (or TL071) for IC8.

Incidentally, the ferrite rod tuned circuit, plus the three stages tuned to 13kHz, provide the total selectivity of the receiver. Output from IC10 is fed directly into one section of IC11, the quad 2-input NAND Schmitt trigger. This squares up the receiver signal. Another section (input pins 12 and 13) of IC11 squares up the 13kHz signal from the multiplier stages as discussed previously.

From IC11, the two 13kHz signals are fed to pins 14 and 3 of IC12, a 4046 which serves as a phase discriminator. The resultant DC voltage output from pin 2 is filtered by R32 and C34 and then passes through a further passive filter consisting of VR11 and C35.

The voltage from the time constant is then fed into IC13, a CA3130 connected as a voltage-follower. The output from pin 6 is fed via VR12 to the metering circuit and also to variable capacitance diode D2, to keep the crystal oscillator phase-locked to the incoming receiver signal.

The receiver signal from IC10, as well as going to IC11, is also fed to a rectifier consisting of D4, D5, C41 and R35. The resulting DC is then fed via emitter follower Q8 to the metering circuit.

The oven circuit, which is used to stabilise the crystal temperature, was described last month.

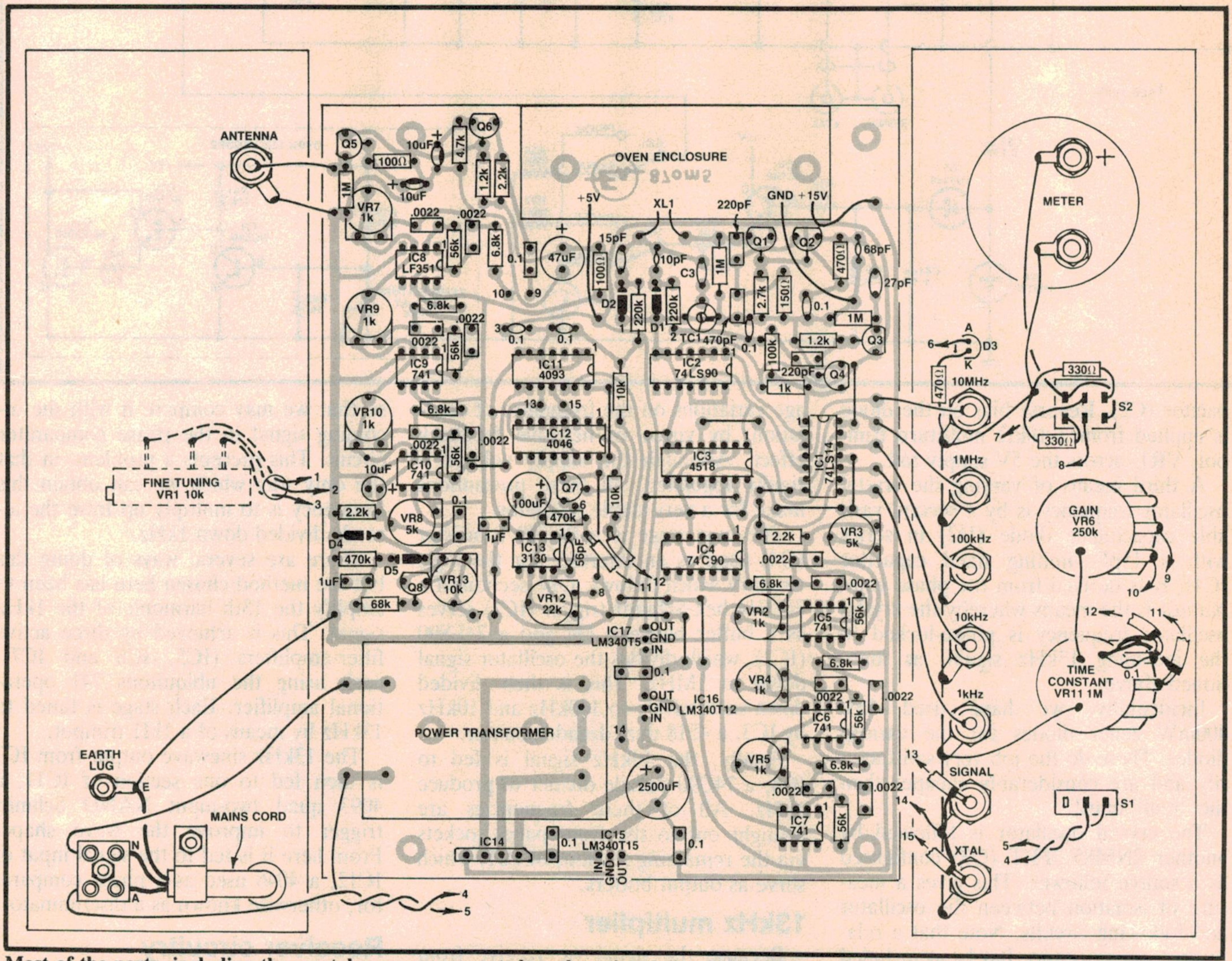
Power requirements are provided by a PL15-5VA transformer, the output of which is rectified by a 1A in-line bridge. All three output voltages are regulated, the three-terminal regulators being connected in series to give very rigid regulation of the 5V supply.

Assembly

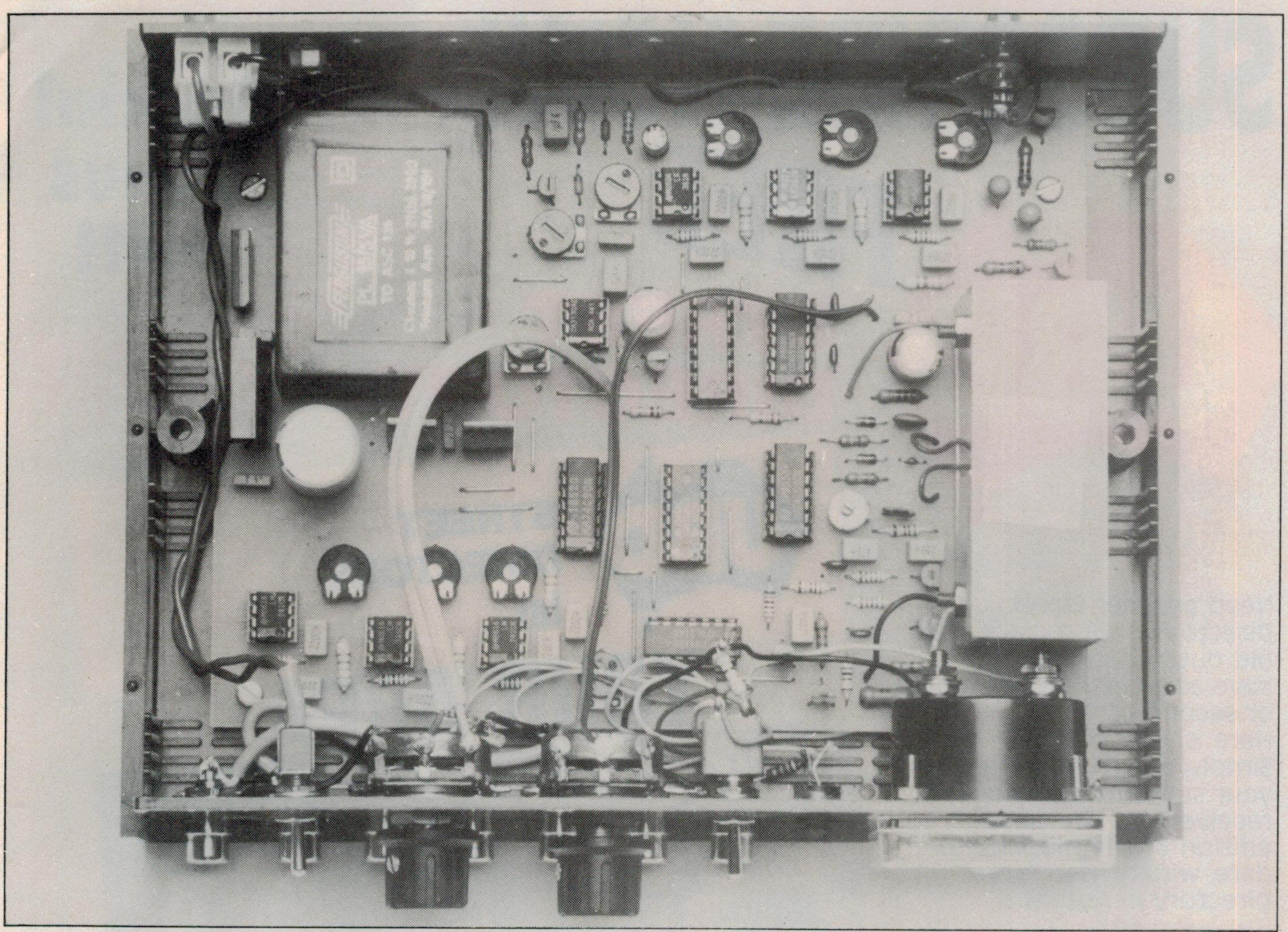
The prototype was assembled into a standard plastic instrument case which is available from most parts retailers. Construction is straightforward with most of the parts mounted on a printed circuit board measuring 172 x 127mm and coded 87om5.

Assembly can begin with the PCB. It is a good idea to fit the wire links first (18 in all), followed by the resistors and diodes. The larger components can then be installed, followed by the transformer and the crystal oven assembly.

We used sockets for the ICs but these can be regarded as optional. Be sure to install all semiconductors with the correct polarity and make sure that you don't get the transistors mixed up. Note that a small clip-on heatsink should be fitted to the 15V 3-terminal regulator



Most of the parts, including the crystal oven, are mounted on the printed circuit board. Be sure to use shielded cable where indicated and note the 0.1μF capacitor on VR11.



Take care with the mains wiring and the wiring to the front panel. Sleeve the terminals of the mains switch (S1) with plastic insulation to prevent accidental shock.

(IC15).

When fitting the oven, a solder lug should be provided under the fixing nut towards the rear of the board. A short earth lead is then run as shown on the wiring diagram. The five leads from the oven are terminated directly to the PCB.

Having fitted the components to the board, it is a good idea to check carefully the work so far, making sure that all components are in the right place and that their polarities are correct.

Before putting the board aside, there are several leads which should be fitted. Along the front edge of the board, there are five pads providing outlets for 10MHz through to 1kHz. Solder short lengths of hookup wire to these so that they can later be terminated at the appropriate RCA sockets on the front panel. The two leads for the gain control (VR6) may be a twisted pair or a pair stripped from ribbon cable.

Note that the leads to VR11 must be shielded. A convenient way of doing this is to use a short piece of shielded stereo cable. The shield should be cut off short at the board end as it is only earthed at the panel end. Make sure that there are no loose ends near the board to cause trouble later on. It is a good idea to wrap the ends with a small piece of insulation tape to prevent any possible trouble.

At the rear of the board, the antenna and earth leads are terminated to the RCA antenna input socket. These leads should be kept as short as possible.

The following six leads are fitted to the underside of the board: two leads from pads near the transformer are run later on to the meter switch (S2a,b); three leads from points near the oven assembly run to the multiturn trimpot (VR1) on the back panel; and a lead is run from the board to the LED on the front panel.

Leads for the mains wiring must also be provided, along with an earth lead from a point near the transformer for later connection to an earth lug on the rear panel. All these leads should be of 240V AC rating.

Finally, there are two shielded leads from points near the middle of the board. These are for the XTAL (crystal) and signal sockets. As in the earlier case, they are not earthed on the board. The braid should be cut off short and steps taken to ensure that no stray braid leads are left to cause trouble later on. The board may now be put aside for the time being.

The case

The next step is to prepare the bottom half of the case and the front and rear panels. To provide some ventilation, we drilled seven 6mm-diameter holes 19mm apart and 54mm from the front edge of the bottom of the case. A number of pillars are moulded on the bottom of the case and these will interfere with the underside of the board when it is fitted later on. To avoid this problem, these pillars, with the exception of the four mounting pillars, should be drilled down until they are nearly flush with the inside face.

The rear panel is next. Thirteen holes need to be drilled. These include a set of ventilation holes similar to those on the bottom of the box. As before, they

are 6mm-diameter holes spaced 19mm apart, and are 12mm from the top edge of the panel. In addition, there is a hole for the antenna input socket, one for the mains lead grommet, and one each for the mains terminating terminal strip, cable clamp and earth lug. Finally, a hole is needed for the three leads to VR1.

If you wish, VR1 could be mounted inside the case rather than on the outside as on the prototype. In this case, it will be necessary to drill a small hole in the top of the box to allow for screwdriver adjustment of the trimpot. The trimpot on the prototype was fixed in place with cellulose adhesive.

Preparation of the front panel is next. Before fitting the Scotchcal overlay, it is best to drill all the holes first. Fitting Scotchcal overlays to panels can be very tricky and calls for care and patience. Once the adhesive has grabbed any part of the panel, it is difficult to remove so it is important that they be properly aligned before contact is made.

Having fitted the Scotchcal overlay, the necessary holes can be cut using a sharp knife. This should also be done with care — one slip and there could be a nasty scratch on your new panel!

Mounting the various components on the front panel is relatively straightforward. When fitting the seven RCA sockets, each earthing solder lug should be angled so that a piece of tinned copper wire can be run along and soldered at each lug. After fixing the LED, a 470Ω resistor is connected between it and the earth bus just mentioned.

Note that the metering toggle switch has two 330Ω resistors mounted directly on it. Similarly, the time constant potentiometer has a 0.1μF capacitor (C34) strung between one of its terminals and the pot body.

The various leads can now be connected to the front panel hardware. Exercise care during this procedure, as a mix up will give confusing results later on! The two leads for the meter come from the metering switch. Make sure that the LED polarity is correct and note that the earth braid on the leads to the time constant potentiometer and the XTAL and signal sockets are connected at the panel end only. The lugs on the power on/off switch should be covered with sleeving to prevent accidental shock.

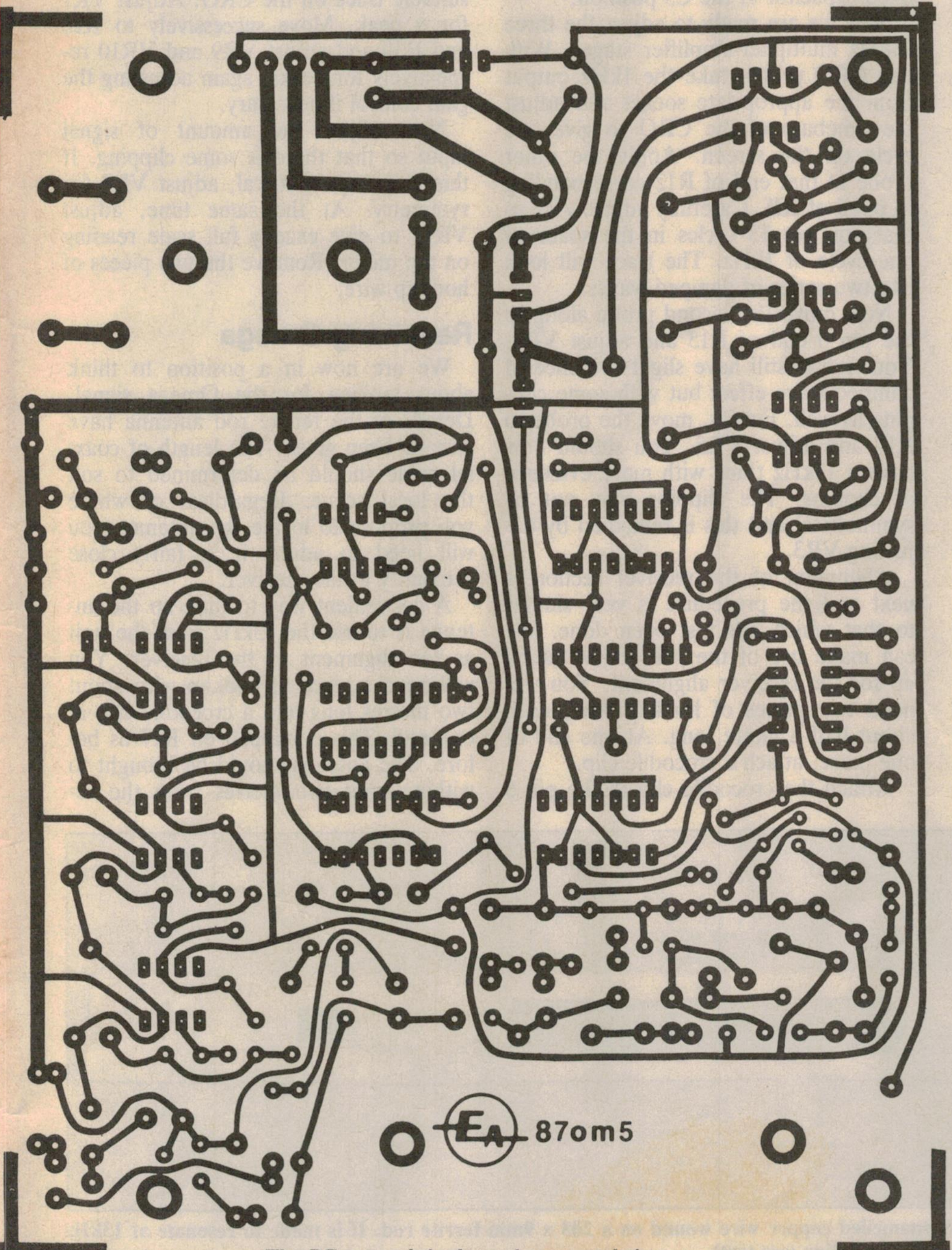
With the PC board fitted into the box and with the front and back panels fitted and connected up, the job of construction is almost complete. However, before we can embark on the testing procedure and finally putting the device into operation, we still need an antenna.

Antenna

The ferrite rod used on the prototype was obtained from Geoff Wood Electronics and should also be available from other outlets. The rod is 203mm long and 9mm diameter. I suggest that you make up or otherwise obtain a piece of cardboard tubing which is a neat slide fit over the rod and about 175mm long. On this tube, wind on about 500 turns (about 150mm long) of 30 B&S enamelled copper wire. The ends may be terminated by taping them securely.

The inductance of the winding used for the prototype was measured at a little over 13mH. This resonated at 13kHz with about 0.012μF. This figure includes the capacitance of the length of coaxial cable between the antenna and the receiver.

Incidentally, the antenna cable should be at least three metres long, otherwise you may experience feedback problems. The maximum length of cable need only be limited by the amount of capacitance it places across the loopstick winding for resonance.



The PC artwork is shown here actual size.

The loopstick winding should be mounted on a suitable piece of timber to avoid any possibility of breakage of the ferrite rod. The amount of lumped capacitance needed to bring the loopstick to resonance may be placed across the winding at the rod end, or it may be conveniently placed across the cable at the receiver end.

Setting up

With the construction completed and having made a thorough check of your work, we are now ready to set up and put the instrument into operation. There is quite a lot to do and I suggest that the following procedure not be rushed but carried out systematically. A CRO is essential for setting up, as well as a shortwave radio to give access to a standard frequency signal, such as VNG.

A multimeter and an audio generator will also be useful. It will be assumed that the oven assembly has already been checked and found to be working properly. Before proceeding, make sure that the mains on/off switch is properly covered to avoid accidental contact.

Set all trimpots to mid-travel and set the time constant potentiometer fully anticlockwise. The gain control may be set at or near fully clockwise to start with. Switch on and check the voltages at the outputs of IC15, IC16 and IC17. These should be close to 15V, 12V and 5V respectively.

With the probe of your CRO, preferably set to 10:1, check that you have output at each of the RCA sockets, from 10MHz through to 1kHz. Now tune in a standard frequency station on your receiver. If it is VNG on 7.5MHz, then take the output from the 100kHz socket and bring the lead close to the antenna input of your receiver, such that you get a good audible beat.

Adjust trimmer TC1 so that the beat goes through zero and out the other side. Set TC1 as near as possible to the point which gives zero beat. Now turn on the BFO on the receiver, as for SSB or CW. Once again, you should hear a slow beat note. Adjust the fine tuning trimpot (VR1) until the slow beat disappears.

This should establish a condition whereby the crystal oscillator will come into phase lock when the signal from Omega is received later on.

Although unlikely, if you have trouble adjusting the crystal oscillator to zero beat, with trimmer TC1 near minimum, then you will have to fit a small fixed capacitor at the C3 position.

Now we are ready to adjust the three 13kHz multiplier-amplifier stages. With one CRO probe, take the 1kHz output from the appropriate socket and adjust the timebase of the CRO to give one cycle on the screen. Apply the other probe at that end of R12 corresponding to pin 6 of IC5. Carefully adjust VR2 so that you get 13 cycles in the space of one cycle of 1kHz. The trace will look like two series of damped waves.

Now move the second probe along to the pin 6 end of R15 and adjust VR4. You should still have slight evidence of damped wave effect but with some clipping as well. Finally, move the probe to R17 and adjust VR5. You should now have a 13kHz trace with more evidence of clipping. The clipping may not be symmetrical and this is remedied by adjusting VR3.

Alignment of the receiver section is next and the procedure is very similar to that which has just been done. We can make use of the 13kHz just tuned up for the receiver alignment. You will need two pieces of hookup wire, each about half a metre long. At one end of one piece, attach a crocodile clip.

Attach the crocodile clip to the pin 6 end of R17. This is our source of 13kHz. The other piece of hookup wire should have one end bared for about one centimetre and folded back, so that it will fit into the antenna socket, thus providing a short antenna. During the alignment procedure, there will need to be some judicious juggling of the respective positions of the two pieces of wire, along with the setting of the gain control, to give a suitable amount of input so that alignment can be achieved.

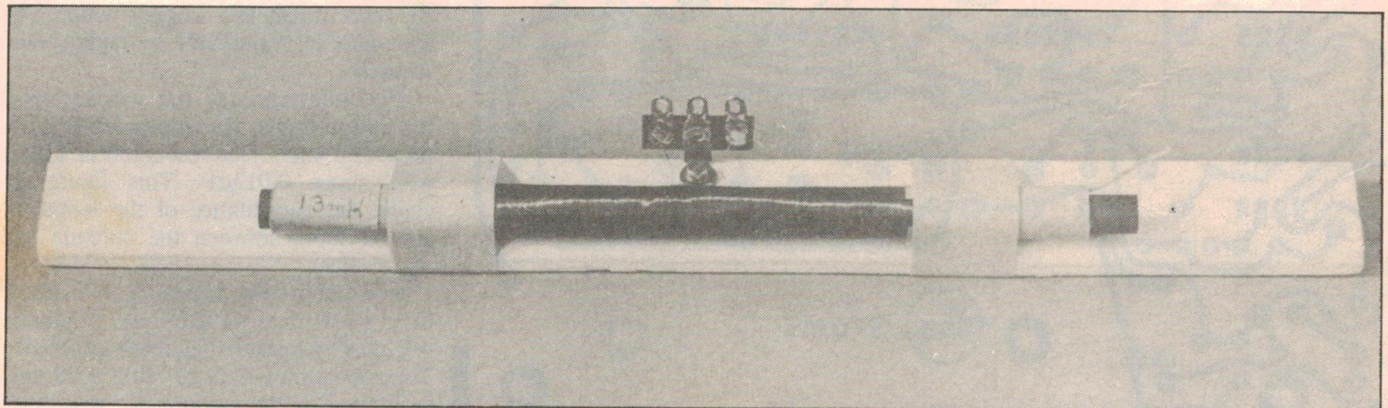
Set the metering switch to "signal". You will only need one CRO probe for this operation. Apply the probe to the pin 6 end of R25 and arrange the two wire leads and the gain control to give a suitable trace on the CRO. Adjust VR7 for a peak. Move successively to R28 and R30 and adjust VR9 and VR10 respectively for peaks, again adjusting the gain control if necessary.

Now adjust the amount of signal input so that there is some clipping. If this is not symmetrical, adjust VR8 for symmetry. At the same time, adjust VR13 to give exactly full scale reading on the meter. Remove the two pieces of hookup wire.

Receiving Omega

We are now in a position to think about looking for the Omega signal. Details of the ferrite rod antenna have already been given. The length of coaxial cable should be determined to suit the local scene. Regardless of where you propose to locate the antenna, you will need to adjust it in fairly close proximity to the receiver.

A convenient way to tune up the antenna is to use the 13kHz from the unit as for alignment of the receiver. You will need a piece of hookup wire about two metres long and a crocodile clip at one end. This is clipped on R17 as before. The antenna should be brought to within about two metres from the re-



The antenna consists of 500 turns of 30 B&S enamelled copper wire wound on a 203 x 9mm ferrite rod. It is made to resonate at 13kHz by connecting a capacitor (C19) in parallel with the winding (see text).

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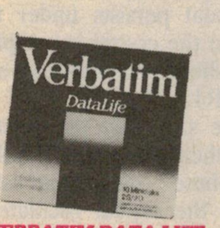

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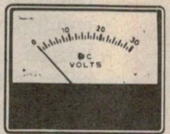

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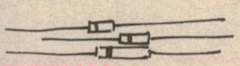

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PN3640	.18	.16	PN3641	.10	.08
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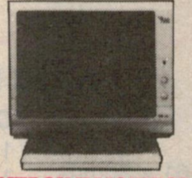

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W12634	34 Way	44.00	42.00	39.00	34.00
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M16672 6672 240V 15-30V 1A tapped	8.95	8.75	8.40

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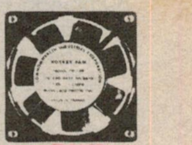

FANS

Cat.No.	Descript.	1-9	10+	100+
T12461	240V 4 1/2"	11.00	10.00	9.00
T12465	240V 3 1/2"	11.00	10.00	9.50
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T12467	115V 3 1/2"	11.00	10.00	9.50

(Fan guards to suit also available)
Plus 20% tax where applicable

ceiver. The hookup wire should be brought near the antenna and the gain control adjusted for a suitable amount of signal, say about half scale on the signal strength meter.

Now slide the ferrite rod inside the coil winding until a signal peak is indicated on the meter. If the winding ends up symmetrically about the rod with signal strength increasing, then more capacitance must be added. If, on the other hand, the rod is well out of the winding before a peak is obtained, then the reverse will apply. The idea is to get resonance with the winding almost in the centre of the rod. Once determined, further movement of the rod should be prevented with some adhesive tape or other suitable means. Disconnect the crocodile clip and hookup wire.

You should now be able to pick up the Omega signal. The antenna should be oriented for maximum signal. This will be at right angles to the direction of the transmitter, which is near Sale in Victoria. The signal meter will respond with the signal pulses, along with the signal indicating LED. The gain control may be conveniently set to give a reading of about 80% of full scale.

At this stage, the frequency of the crystal should be checked against VNG as before by using the BFO to detect any beat. Now there is a fine point here. You may well hear a beat, even though the crystal is phase-locked to Omega. Due to the short time constant setting, there will be a certain amount of hunting about the mean frequency. This phenomenon will disappear when the time constant is increased to say half way, corresponding to about 50 seconds. If the beat persists under these conditions, then the crystal is not phase-locked and it should be adjusted either with TC1 or VR1.

Having made sure that the crystal is phase-locked, then the meter should be switched to "phase" and a final adjustment made to the crystal oscillator by means of VR1, for a centre-scale reading.

An alternative method of checking that the crystal oscillator is phase-locked to the incoming signal is to use your CRO. Feed the XTAL socket output into one channel and the "signal" output into the other channel. Adjust the respective traces for height so that there are say between three and five cycles each on the screen. There should be about a 90 degree phase difference between the two signals and they should remain that way.

If the phase difference is obviously not 90 degrees and they are drifting with respect to each other, then they are not locked.

The direction of drift of one signal with respect to the other will give a clue as to which way the oscillator needs to be shifted to bring it back.

Using the standard

A few comments may be in order on making the best use of your frequency standard. Best short term stability will be obtained when the phase difference between the two signals is exactly 90 degrees, as indicated by a centre reading on the phase meter. Under these conditions, the time constant control may be

PARTS LIST

- 1 PCB, code 87om5, 127 x 171mm
- 1 PCB, code 87ov4, 61 x 36mm
- 1 copper clad fibreglass sheet, blank size 164 x 69mm (see drawing)
- 1 plastic instrument case, 200 x 160 x 70mm
- 1 Scotchcal label, 194 x 63mm
- 1 0-1mA meter, 43 x 43mm
- 1 Ferguson PL15/5VA PC-mounting transformer
- 1 mains cord and plug
- 1 cord clamp
- 1 earth lug
- 8 RCA panel-mounting sockets
- 1 SPDT miniature toggle switch
- 1 DPDT miniature toggle switch
- 2 knobs (19mm)
- 1 5mm LED and bezel
- 1 ferrite rod 240mm long x 9.5 diameter, or larger
- 7 8-pin IC sockets
- 4 14-pin IC sockets
- 2 16-pin IC sockets
- 1 heatsink for LM340T15, 7815
- 1 10MHz crystal, 30pF, HC-18/U, or similar

Semiconductors

- 5 741 op amps
- 1 LF351, TL071 op amp
- 1 CA3130 op amp
- 1 74LS14 hex Schmitt trigger
- 1 74LS90 decade counter
- 1 74C90 decade counter
- 1 4046 phase-locked loop
- 1 4093 quad 2-input Schmitt trigger
- 1 4518 dual synchronous up counter
- 1 LM340T-15, 7815 +15V regulator
- 1 LM340T-12, 7812 +12V regulator
- 1 LM340T-5, 7805 +5V regulator
- 1 1A in-line bridge rectifier (available from Geoff Wood Electronics)
- 3 2N5485 FETs
- 2 BC548 transistors
- 5 BC549 transistors
- 1 MJE3055 transistor
- 2 1N4148, 1N914 diodes
- 2 15V 400mW zener diodes

Capacitors

- 1 2500μF 25VW PC electrolytic
- 1 100μF 16VW PC electrolytic
- 1 47μF 16VW PC electrolytic
- 3 10μF 10VW PC electrolytics
- 3 1μF polypropylene
- 10 0.1μF polypropylene
- 12 0.0022μF polypropylene
- 1 470pF polypropylene
- 2 220pF polypropylene
- 1 68pF NPO ceramic
- 1 56pF NPO ceramic
- 1 27pF NPO ceramic
- 1 15pF NPO ceramic
- 1 10pF NPO ceramic

Resistors (5%, 0.25W)

3 x 1MΩ, 2 x 470kΩ, 2 x 220kΩ, 1 x 100kΩ, 1 x 68kΩ, 6 x 56kΩ, 3 x 10kΩ, 7 x 6.8kΩ, 2 x 4.7kΩ, 1 x 2.7kΩ, 3 x 2.2kΩ, 2 x 1.2kΩ, 2 x 1kΩ, 2 x 470Ω, 2 x 330Ω, 1 x 150Ω, 2 x 100Ω, 1 x 5kΩ multiturn miniature trimpot, 1 x 10kΩ multiturn miniature trimpot, 1 x 22kΩ miniature trimpot, 1 x 10kΩ miniature trimpot, 2 x 5kΩ miniature trimpots, 6 x 1kΩ miniature trimpots, 1 1MΩ linear potentiometer, 1 250kΩ linear potentiometer

Miscellaneous

Hookup wire, single shielded cable, stereo shielded cable, tinned copper wire, foam insulating material, screws, nuts, solder.

*Note: This list includes the parts needed for the temperature controlled crystal oven described in the April 1987 issue of EA.

Where to buy the parts: parts for this project are readily available from most retailers. The crystal, PCBs, Scotchcal label, and meter are available from Geoff Wood Electronics, while the PCB can also be purchased from RCS Radio.

advanced to at least half way, corresponding to 50 seconds. If noise is not a problem, then the time constant may be advanced to the full 100 seconds.

If the crystal oscillator shows a noticeable phase shift, as indicated on the meter and with the time constant set well up, then there is the possibility of the oscillator pulling out of lock. If serious measurements are being taken, these points should be taken into account.

At the beginning of this article, mention was made of possible applications of the instrument. By way of an example, we put it to use on the 500MHz 7-digit Frequency Meter as described in *Electronics Australia* in December 1981. This is how we did it.

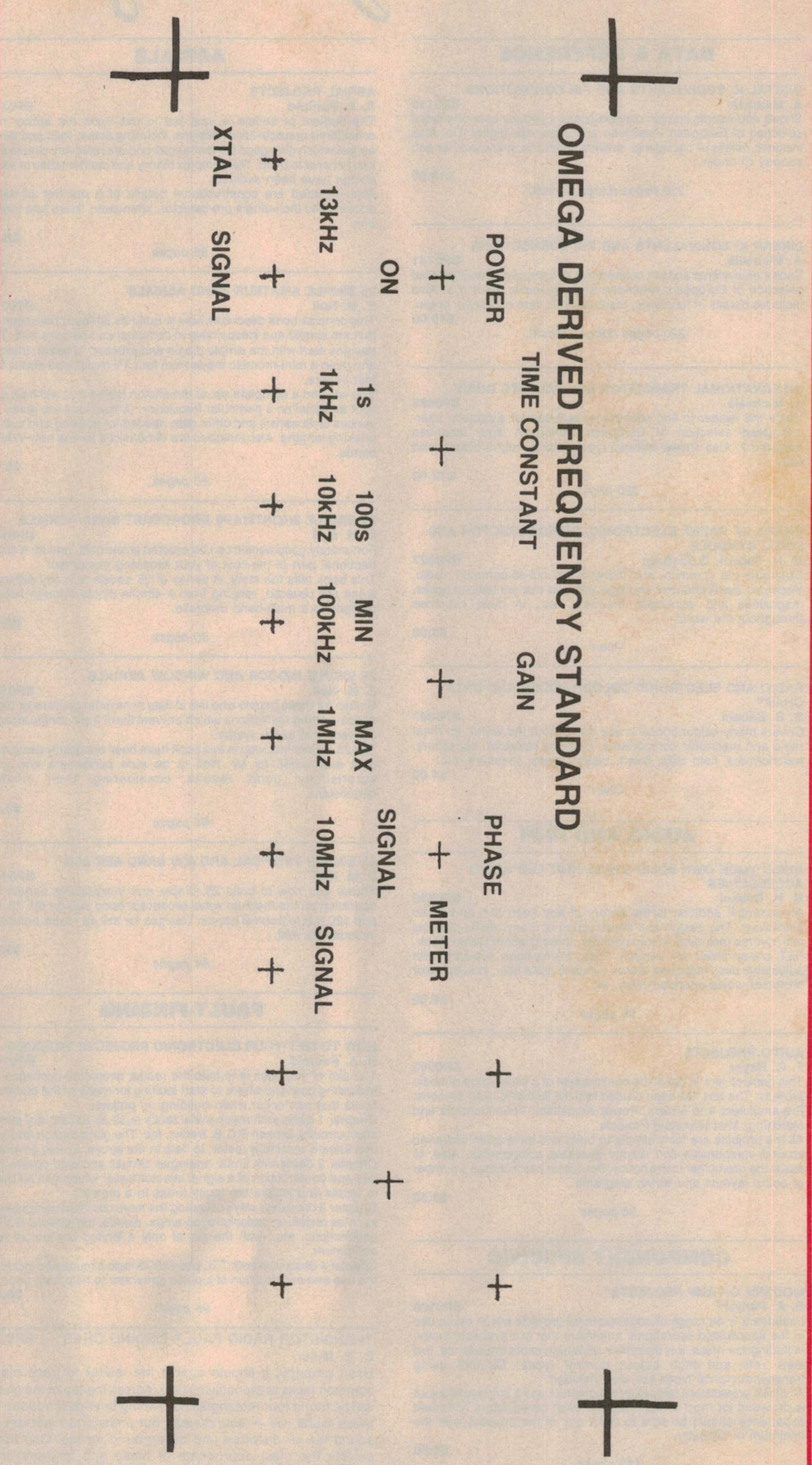
Output at 10MHz is taken from the standard, via a piece of coaxial cable about 500mm long. The other end of the cable is fed into pin 25 of the ICM7216A IC, via a 10pF fixed capacitor. The braid of the coaxial cable is grounded at both ends. This is sufficient to firmly lock the crystal oscillator in the frequency counter. Thus, we have the crystal oscillator locked to the incoming Omega signal.

The following is a set of figures which I obtained with this setup and which should serve as a guide as to what may be achieved. The frequency to be measured was at 1MHz and was derived on an independent system, using NWC (North West Cape) on 22.3kHz as the source. The 1MHz was fed into the input of the frequency meter, with gating set at 10 seconds. Readings were then taken every ten seconds for a period of four minutes.

Of the 24 readings taken, there were only three different ones. These were, 1000000.0, 999999.9 and 1000000.1. For the sake of brevity, I will quote the figure after the decimal point for the 24 readings. They are: 0, 1, 9, 0, 0, 0, 0, 0, 0, 0, 0, 0, 9, 1, 9, 0, 1, 0, 9, 1, 0, 0, 0, 0, 1.

Taking the average of the above figures, we get 1000000.011. This amounts to an error of 1.1 parts in 10^8. If we took readings over a longer period, we would end up with a more accurate result.

Ideally, the frequency standard should be left running continuously. After being switched on from cold, the oven heats up very quickly, with phase-lock being achieved in a couple of minutes, with a short time-constant setting. However, good stability is not achieved at this stage and a period of up to one hour should be allowed if serious measurements are to be taken.



Above: actual size front panel artwork. A ready made Scotchcal label is available from Geoff Wood Electronics. Etched PCBs can be purchased from either Geoff Wood or RCS Radio.

Back by Popular Dem

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FM radio tuners — 1

The FM system, noise, bandwidth, stereo

From tentative beginnings in the 1930s, FM (frequency modulation) radio has since become an integral part of the home hifi music scene. In this article we explain how it differs from the original AM system both in respect to basic technology and what it can offer to the average listener.

In the case of AM radio, audio information is added to the high frequency carrier in such a way that the carrier amplitude is varied — or modulated — in sympathy with the instantaneous audio signal voltage. The carrier frequency is nominally unaffected although, as indicated in the previous article, the process of amplitude modulation does generate additional high frequency components, in the form of "sidebands" dispersed on either side of the original carrier.

With frequency modulation, the opposite applies: addition of the audio information leaves the amplitude of the carrier nominally unaffected but its frequency is made to deviate to either side of the unmodulated value in sympathy with the instantaneous audio signal voltage (Fig.1c).

Typically, if the high frequency carrier is modulated by a 1kHz tone, the carrier will deviate to either side of its allotted frequency at a 1kHz rate. When a program signal is involved, the deviation rate varies rapidly and continuously as it responds to the complexities of the audio signal envelope.

The actual extent of the frequency deviation — expressed as so many kHz plus and minus — dep nds on the instantaneous strength or amplitude of the modulating audio signal. The larger the audio signal, the greater will be the deviation or overall carrier "swing", and therefore the degree of frequency modulation.

As noted in the last chapter, there is a natural limit to the degree or "depth" of amplitude modulation, which is considered to be 100% when the instantaneous amplitude of the carrier reaches zero on the downward swings and double its normal value on positive swings.

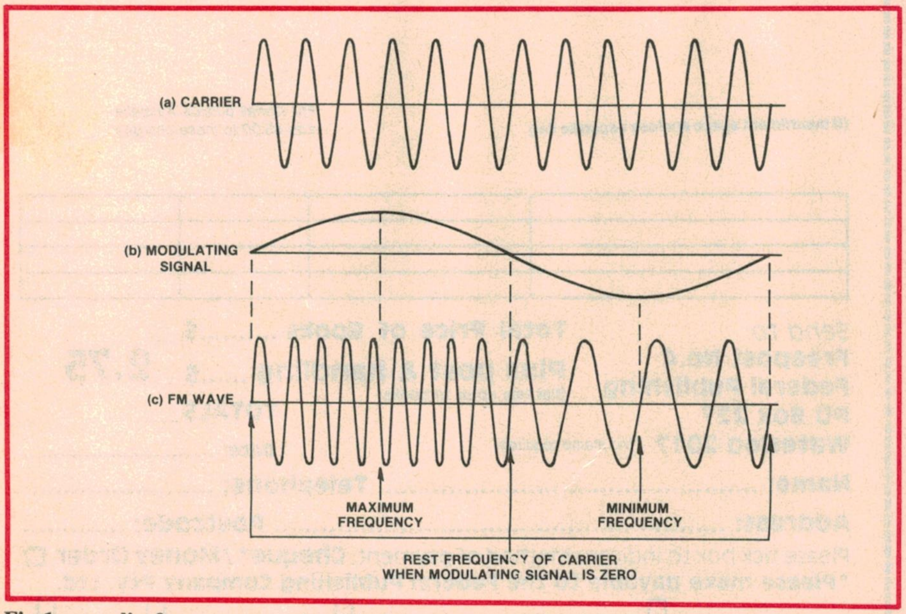


Fig.1: a radio frequency carrier (a), frequency modulated by an audio tone (b) assumes the general form depicted in (c).

With FM, there is no comparably unambiguous bench mark and the permissible frequency deviation is more a matter of compromise and technical convenience. In practice, the limit is normally specified by international (CCIR) regulatory standards, applicable to the particular type of service, being quite different for FM broadcasting and, for example, FM mobile communication systems.

On that basis, an FM transmitter may be said to be 100% modulated when the peak carrier deviation reaches the relevant mandatory limit.

A term frequently encountered in this general context is the "modulation index" or, more explicitly, the "modulation factor" (mf) which, by definition, is equal to:

$$\frac{\text{Frequency deviation of the carrier}}{\text{Modulating frequency}}$$

By way of example, a 4kHz audio tone of given amplitude, used to frequency modulate a 100MHz carrier, might conceivably cause it to deviate by ±25kHz (at a 4kHz rate); ie, between 100.025MHz and 99.975MHz. The modulation index in this particular case would be:

mf = 25MHz/4MHz = 6.25

While it has a general application, the modulation index is most commonly used to indicate the amount by which the carrier of any given FM transmitter is designed to deviate, when fed with modulating signals of a stated frequency and maximum peak amplitude. The figure is particularly significant as an indicator of the ability of an FM transmitter or system to cope with higher modulation frequencies.

Fairly obviously, the higher the stated modulation index for any given audio signal, the greater must be the carrier deviation and therefore the effective degree of modulation. (For a more detailed discussion see "Frequency Modu-

lation and Sidebands" by John Kennewell and Kenneth Brown, *Electronics Australia,* November 1983).

AM, FM and noise

A problem affecting all radio reception is that of noise interference, variously due to atmospheric "static", man-made electrical interference and "hiss" generated within the signal processing circuits of the receiver itself. Most such noise is interpreted by a receiver as amplitude modulation of the incoming carrier.

AM receivers, designed specifically to detect and reproduce AM components on the carrier, reproduce noise interference virtually as an integral part of the wanted signal (Fig.2), thereby making it very difficult to discriminate selectively against the noise.

By contrast, with an FM system, it is readily possible to design receivers such that, by a process of signal "limiting", they can suppress noise/amplitude variations, without compromising the wanted audio component implicit in the frequency modulation (Fig.3).

The overall signal/noise ratio attainable in an FM system depends primarily on:

(1) the strength of signal available to the receiver; and

(2) the degree or depth of frequency modulation employed — with the obvious implication that FM transmissions should feature the highest possible modulation index.

FM sidebands

This last observation is certainly true but it is also a fact that, compared with AM, FM is very demanding in terms of signal bandwidth, involving sidebands which theoretically extend indefinitely on either side of the carrier (fc) by multiples of the modulating frequency (fm): ±fm, ±2fm, ±3fm etc, as indicated in Fig.4.

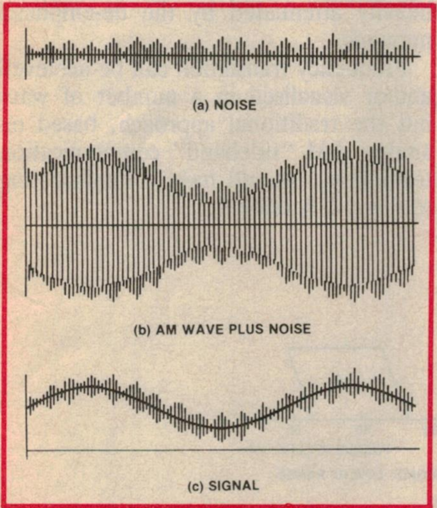


Fig.2 (above): in an AM system, noise interference appears as an additional variation in the carrier amplitude and is reproduced as such by the receiver.

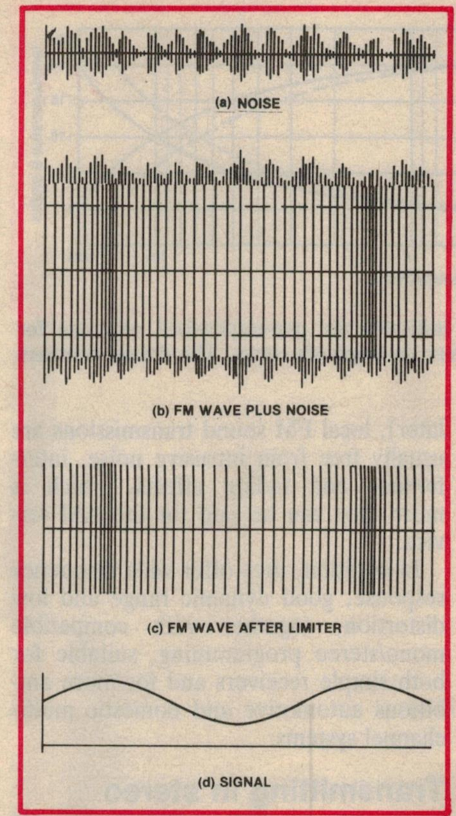


Fig.3 (right): in an FM system, the receiver can be designed to substantially reject variations in carrier amplitude, responding only to frequency modulation.

With a complex modulating signal, as distinct from a single tone, sidebands are generated for every component frequency present, as well as for their countless sum and difference combinations!

Fortunately, the power level of the outer sidebands is low enough to render most of them insignificant, but the spectrum occupied by those that do matter is still quite substantial for a system that needs to cope with audio frequencies to at least 15kHz, and a modulation index sufficient to ensure adequate noise immunity for hifi listening.

Based on "rule of thumb" calculations, it can be said that broadcast quality FM transmissions involve significant sidebands occupying an overall bandwidth approximating 200kHz in mono mode and approaching 300kHz for stereo.

Because of such bandwidth requirements, it is not practical to accommodate FM broadcast stations in the already congested MW (medium wave) and HF (high frequency) bands. Instead, by international agreement, the segment 88-108MHz in the VHF band has been set aside for FM broadcasting, with potential to provide up to 95 usable channels, each 200kHz apart.

(In some countries, including Australia, the above segment is currently shared with TV stations or other services but that anomaly is in the process of correction.)

Australian FM stations conform to CCIR recommendations, with a maximum carrier deviation of ±75kHz. Other performance parameters include a frequency response of 30Hz to 15kHz, within full modulation. Unweighted noise level, relative to full modulation at 400Hz, is required to be –70dB or better in mono mode, and –67dB in stereo.

(Based on the above, the modulation index at 15kHz works out at 75kHz/15kHz = 5).

In Australia, the ERP (effective radiated power) ranges from as low as 10W (for a local community service) to 150kW, depending on the nature of the station, its location and the coverage required (see stations list, March 1986 issue).

Treble pre-emphasis

As a further measure to improve signal/noise ratio, all FM broadcast services use treble "pre-emphasis" (or boost) during transmission, with a corresponding degree of "de-emphasis" (or attenuation) provided in FM receivers and tuners.

This is possible because, in a normal program signal, the amplitude of the higher audio frequencies tends to taper

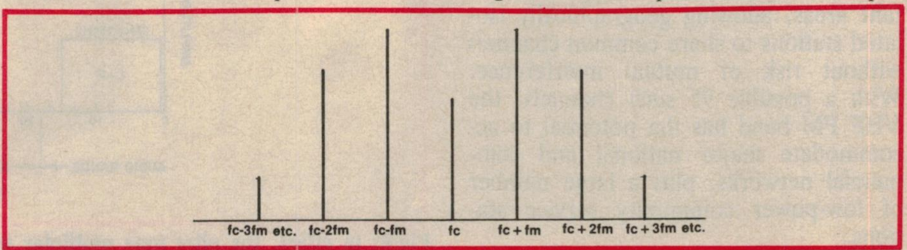


Fig.4: a frequency modulated waveform consists of an infinite number of sidebands but, fortunately, not all of them have enough power to be significant.

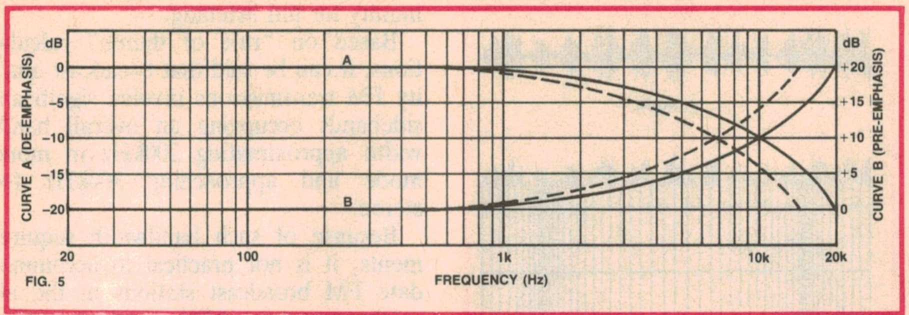


Fig.5: the solid curve "B" (50μs contour) indicates the pre-emphasised response for transmission. "A" is the corresponding receiver de-emphasis curve. The dotted contours are for the now discarded 75μs figure.

off relative to that of the middle and low frequencies. In ordinary circumstances, therefore, the modulation capability of the transmitter — and the permissible modulation index — would be under utilised.

By pre-emphasising the high frequencies during transmission, and de-emphasising them by an equal amount in receivers, the overall audio response remains level but any noise penetrating the signal path between the transmitting antenna and the receiver audio system is attenuated as per the de-emphasis curve, thereby rendering it subjectively less apparent.

Early practice in the USA was to use pre-emphasis and de-emphasis curves as defined by a filter time constant of 75μs (Fig.5) but this was reduced to the 50μs contour with the introduction of stereo broadcasting. In Australia, as in Europe, the 50μs contour is standard for all FM broadcasting, including the FM sound channel(s) associated with TV stations.

Signal coverage

Being transmitted in the VHF (very high frequency) band, signals from the FM stations behave in much the same manner as those from VHF TV stations (channels 0-11 in Australia). Radiated from a suitably positioned antenna, they can be directed primarily to serve a few suburbs, a large city and its environs, or specified rural areas.

Because they are not ordinarily subject to reflection from the ionosphere, VHF FM signals do not "skip" into distant areas, allowing geographically isolated stations to share common channels without risk of mutual interference. With a possible 95 such channels, the VHF FM band has the potential to accommodate major national and commercial networks, plus a large number of low-power community service stations.

Assuming the use of an adequate receiver and antenna (more about these later), local FM sound transmissions are usually free from intrusive noise, interference and fading effects, which is more than can be said for the AM service.

In addition, they offer wide frequency response, good dynamic range and low distortion, together with compatible mono/stereo programming, suitable for both simple receivers and for more ambitious automotive and domestic multichannel systems.

Transmitting in stereo

Whether on AM or FM, compatible mono/stereo broadcasting requires that the stereo program signals be specially combined or "matrixed" in the station audio system to derive the so-called sum and difference signals L+R (left + right) and L-R (left — right).

Assuming that the L and R signals are both wideband audio (nominally 30Hz to 15kHz), the sum and difference derivatives can be expected also to contain a similar range of frequencies. Their content and relative amplitudes will vary from instant to instant, however, depending on the nature of the sound source and whether it is concentrated near centre stage (predominantly an L+R signal) or to one or both sides (L-R).

The sum and difference signals both need to be frequency modulated on to the station carrier, but independently and in such a way that mono receivers can totally ignore the L-R component, responding only to the L+R modulation — effectively the "mono" signal.

Stereo receivers, on the other hand, must be able to resolve both the sum and the difference components and to re-matrix or re-combine them, in order to recover the original L and R source signals. Balanced, in-phase signal addition yields the result:

$$(L + R) + (L - R) = 2L$$

Reversing the phase of the difference signal and again adding the two components yields:

$$(L + R) + (-L + R) = 2R$$

In the Zenith/GE pilot-tone multiplex system, which has been adopted worldwide for stereo FM broadcasting, the L+R signal is used to frequency modulate the carrier, exactly as in a mono FM system and as depicted in Fig.1c. To this extent, as far as mono receivers and tuners are concerned, a multiplex transmission is seen as normal mono, being therefore fully compatible.

Frequency "translation"

Because the L-R signal involves the same audio frequency band as the L+R signal, it needs to be modulated on to the carrier in a different manner, such that it will be ignored by mono receivers but accessible to their stereo counterparts.

In the Zenith/GE system, the 30Hz-15kHz L-R signals are moved or "translated" more or less bodily up into the supersonic (or low-RF) region before frequency modulating them on to the VHF carrier (Fig.6). As a result, they fall well outside the resolution capability of mono receivers, being, in any case heavily attenuated by the de-emphasis network.

Frequency translation can be achieved and/or visualised in a number of ways but the traditional approach, based on analog AM "sideband" communication technology, should have a familiar ring to many EA readers.

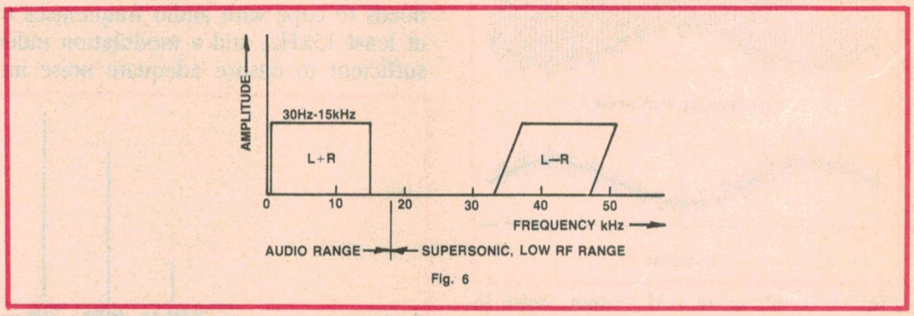


Fig.6: in effect, the pilot tone multiplex system "translates" the L-R signal up into the supersonic or low RF range, where it will not be sensed by mono receivers (see also Fig.7).

It involves feeding the L-R audio signal into a suppressed carrier (SC) or "balanced" amplitude modulator, of one kind or another, along with a high frequency signal — a subcarrier — in the supersonic (or low-RF) range. The output from the modulator consists of a pattern of sidebands distributed on either side of the (suppressed) carrier frequency.

The Zenith/GE system calls for a subcarrier of exactly 38kHz so that, assuming a 30Hz-15kHz program signal, the output from the balanced modulator will comprise an upper sideband block (USB) and a lower sideband block (LSB) equivalent to 38kHz plus and minus 30Hz-15kHz.

Setting aside the sideband jargon, they can be considered simply as two mirror-image blocks of complex supersonic signal voltages, as shown in Fig.7, extending from 23 to 37.79kHz and from 38.03 to 53kHz. The 38kHz signal has been suppressed.

A point to note is that both blocks contain identical audio-derived information and that, when ultimately decoded in stereo receivers, both contribute to the recovered L-R signal. It is for this reason that they are each represented as having half the amplitude of the L+R block.

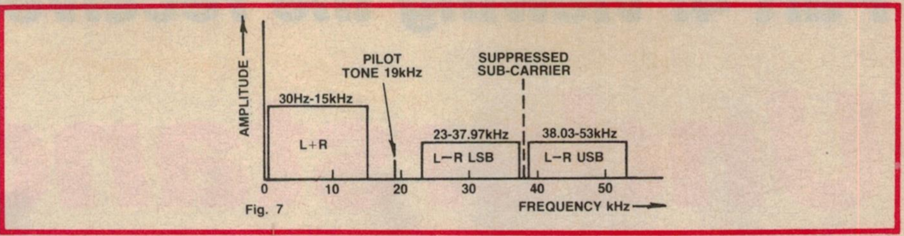


Fig.7: Processed through a balanced modulator, the L-R signal is transformed into two sideband blocks in the range 23-53kHz. The 38kHz carrier can be reconstitued using the 19kHz pilot tone.

The "pilot" tone

But why the insistence on a frequency of 38kHz for the subcarrier? The reasoning should not be too difficult to follow:

If the two sets of supersonic (sideband) signals are to be accurately demodulated, stereo receivers ultimately require either the original subcarrier or the means to reconstitute a local carrier of identical frequency and phase.

To radiate the original subcarrier at full amplitude would commit a disproportionate amount of the FM transmitter's allotted bandwidth to a signal which, of itself, carries no audio information. Yet to transmit it at a much reduced amplitude would pose a problem for receiver designers, because it would have to be filtered out from a complex of sidebands of possibly considerable amplitude and as little as 30Hz away.

The preferred approach is to transmit a 19kHz reference signal, phase locked to the original 38kHz subcarrier. Both may be derived from a common higher frequency source, or either one may be generated by a precision oscillator and the other derived from it by frequency division or multiplication.

At 19kHz, the reference signal is well clear of the audio information, nominally 4kHz above the top limit of the L+R audio signal and 4kHz below the bottom limit of the L-R LSB block. As such, it can be accessed without difficulty in stereo receivers, allowing it to be transmitted at relatively low amplitude, and thereby conserving bandwidth.

The 38kHz subcarrier can be reconstituted in stereo receivers by direct frequency doubling or by using the 19kHz reference to phase-lock a local 38kHz oscillator.

Fig.7, in fact, depicts the complete frequency spectrum of the pilot tone multiplex signal which is frequency modulated on the station's VHF carrier. On the left is the L+R sum or "mono" signal extending nominally from 30Hz to 15kHz. At 19kHz is the reference or "pilot" signal, transmitted at a standard 9% of full modulation level.

The L-R signal blocks extend overall from 23kHz to 53kHz with a break in the middle which originally accommodated the 38kHz subcarrier. System standards require this to be suppressed to less than 1% of full modulation.

The pilot tone, incidentally, has a supplementary role in that its presence serves to alert a stereo receiver to the fact that it is tuned to a stereo transmission. A stereo indicator light comes on and the decoding circuitry switches automatically to stereo mode. On the other hand, if the pilot tone is absent, or is very weak, the lights does not show and the receiver operates in the mono mode.

Stereo bandwidth

A question which arises naturally from the above concerns deviation and bandwidth. Assuming that both are fully exploited in mono mode, how is it possible virtually to double the amount of information broadcast, without breaching established limits and compromising compatibility?

On the basis that one should not expect something for nothing, the simple answer is that a compromise is involved, not in compatibility but in effective modulation depth.

To begin with, the 19kHz pilot tone (9%) and the suppressed 38kHz subcarrier (less than 1%) account for 10% of the permissible carrier modulation or deviation, so that only 90% of the mandatory 75kHz deviation limit (67.5kHz) is available to accommodate the audio signal — a loss of 1dB and a reduction in the modulation index to 4.5 at 15kHz.

In turn, however, this deviation has to be shared by the sum and difference signals, suggesting a further 2:1 or 3dB reduction in the level of each one and a modulation index of 2.25 at 15kHz.

For a mono receiver, responding only to the L+R signal from an average multiplex transmission, the level of recovered audio would be about 4dB down on what could be expected from the same station transmitting in pure mono mode. Over most of the station's service area, this would probably not be subjectively apparent and, to that extent, compatibility is not compromised.

The difference would, however, be evident in fringe situations where the wanted signal is competing with noise interference of one kind or another. We shall have more to say about this later.

While the carrier deviation, as such, can be kept within ±75kHz by carefully adjusting the amplitude of the multiplex modulating signals, their radically different frequency content can widen the spectrum occupied by what were described earlier as "the sidebands that matter". Fortunately, mono receivers can still intercept the sidebands they need with their existing overall bandwidth approaching 300kHz to cope adequately with the L-R components.

Without elaborating further at this stage, it can also be said that stereo receivers and tuners are more subject to noise interference in fringe areas than their mono counterparts. It is for this reason that most are fitted with manual or automatic mode switching so that they can revert to mono mode under fringe reception conditions.

To be continued

Part 4: viewing the received picture

Understanding colour television

The shadow mask picture tube forms the heart of the modern colour TV receiver. Here, we examine the basic principles of the shadow mask tube and discuss the problems of purity and convergence adjustment.

by DAVID BOTTO

Modern colour TV systems make use of the principle of "mixed highs." This, you will remember, simply means that the fine detail of the picture is transmitted as a high definition monochrome signal, together with the accompanying colour information at lower frequencies.

The television receiver circuitry then presents the colour display device with a monochrome or "Y" signal proportional to the brightness of each point of the scanned scene, plus colour information in the form of varying proportions of red, green and blue colour signals. These signals must then be combined by the display device to produce a colour picture which faithfully reproduces the scene at the TV studio.

The display device must be reasonably compact and not prohibitive in cost. It must also be capable of producing a picture which is free from objectionable flicker and with colours of correct hue and saturation.

In addition, the picture should be easy for a family to view in the lighting conditions of the average home. Finally, it must not demand unacceptably complex circuitry in the television receiver, or require continuous adjustment and setting up for satisfactory results.

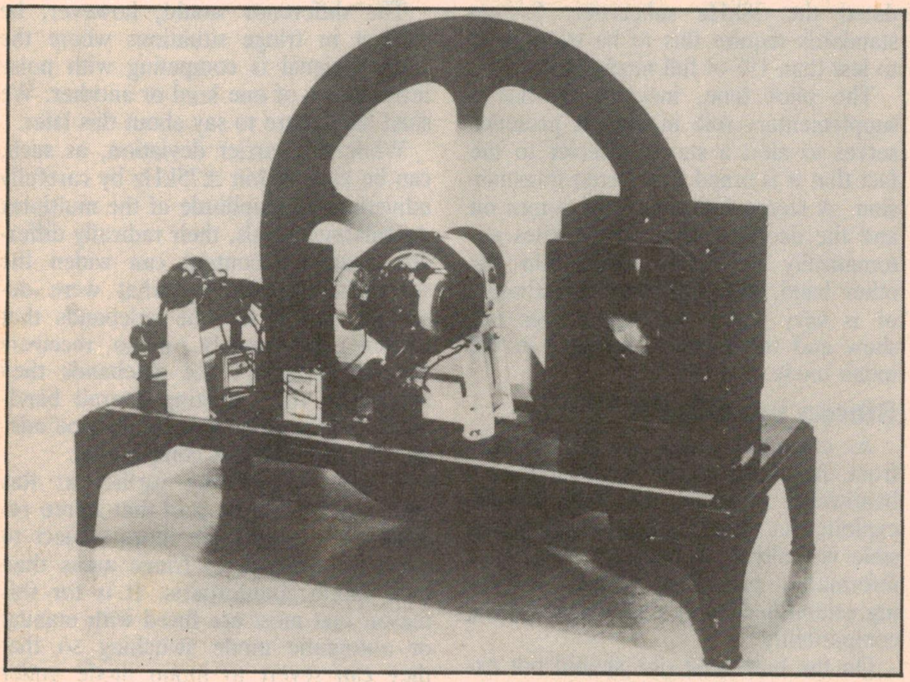


Fig.1: this photograph shows John Logie Baird's scanning disc "televisor", from which his colour "televisor" was developed. (Photo courtesy of The Baird Museum and Radio Rentals Limited, Relay House, Swindon).

Display development

During the development of colour television, many display device ideas were researched and built. Some of these were described in the second article in this series, including the world's first colour television receiver demonstrated by John Logie Baird in 1928. Fig.1 shows his earlier monochrome receiver from which this colour system was developed.

When the British Broadcasting Corporation began to transmit regular colour television programs in 1967, the only practical display device for home use was the tri-gun shadow mask cathode ray tube. The shadow mask tube was invented and developed by Radio Corporation of America, and first demonstrated by that company in 1950. It had the advantage that it could be used with almost any colour television system.

The shadow mask picture tube uses a delta-gun arrangement; so-called because the grouping of the electron guns resembled the Greek letter delta

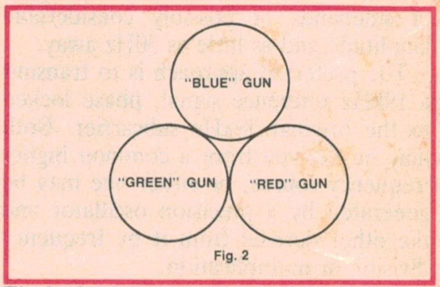


Fig.2: the delta-gun arrangement.

(Fig.2). Delta-gun tubes are no longer fitted in the latest television receivers, although you'll find them still in use in many older colour TVs. Also, some high-definition computer displays use an advanced type of delta-formation tube.

Almost all modern colour tubes are a development of the delta-gun shadow mask tube developed by RCA. Because of this, we need to understand its basic operating principles.

If you consider Fig.3, the shadow mask tube appears as three tubes in one. Deposited inside the faceplate of the tube are dots of phosphors in triangular groups of three, the whole being coated with a thin film of aluminium which reflects light towards the phosphorous material to increase brightness.

Three different kinds of phosphors make up each triangular group, deposited and spaced with precision accuracy. When struck by a beam of electrons, one of the phosphors emits red light, another green light, and the third blue light.

Notice that in Fig.3 the electron guns are labelled Red, Green and Blue.

If we can ensure that the electron beam from the "red" gun hits the correct phosphor dot in each triangular group, red light will be emitted. Similarly, if the beams from the "green" and "blue" guns hit the correct phosphor dots in each triangle, then green and blue light will be emitted. The brightness of the emitted light from each phosphor dot will depend on the intensity of the stream of electrons striking it.

In practice, the three electron beams are deflected together, line by line, by the receiver's scanning circuitry. In this manner, they build up a set of horizontal lines known as a raster.

A single visible raster really consists of three separate rasters, one red, one green, and one blue. Thus, if switches "G" and "B" in Fig.3 were opened, a red raster would be seen. Similarly, if switches "R" and "B" were opened and switch "G" closed, a green raster would be visible. And if "R" and "G" were opened and "B" closed, a blue raster would be visible.

When switches "R", "G" and "B" are all closed, and the intensity of the electron beams from the three guns correctly balanced, a white raster will be seen. This is because the phosphor dots are grouped so closely together that, by additive colour mixing of the red, green and blue primary colours, the eye registers the sensation of white.

To ensure that each electron beam falls on it's correct colour emitting phosphor dots, the three gun assemblies are slightly angled towards each other. This means that, with the receiver scanning circuitry disconnected, and the beams stationary, the three electron beams meet (or converge) at a single spot at the middle of the screen.

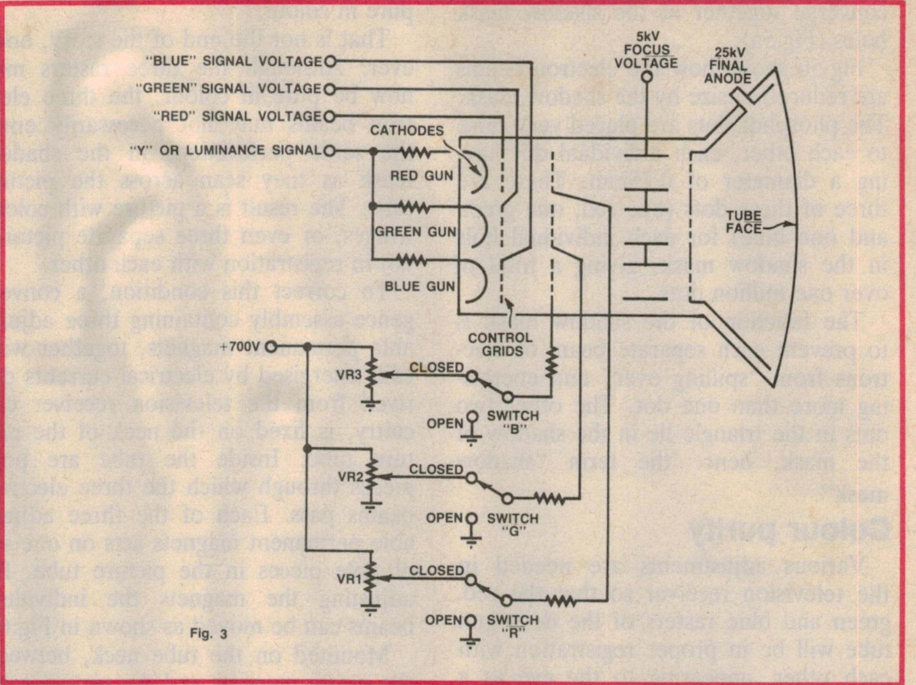


Fig.3: basic schematic of the shadow mask picture tube.

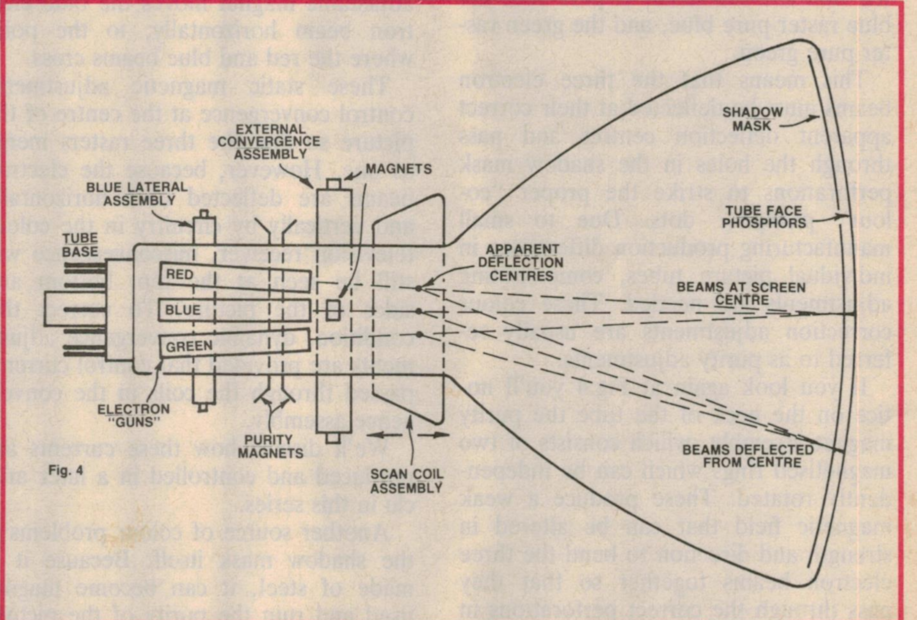


Fig.4: basic arrangement of the shadow mask picture tube showing the electron guns and the external convergence assembly. The shadow mask is positioned just behind the faceplate.

As each electron beam curves through the scanning coils, it is suddenly deflected at a point called the "apparent deflection centre" (Fig.4). The scan coils can be moved up and down the neck of the tube, changing the position of the apparent deflection centre and the position where the beams meet. In the delta-gun shadow mask tube this is an essential adjustment.

The shadow mask

Just behind the tube face is the shadow mask, a fixed steel plate perforated with tiny holes spaced so that each is exactly in line with the centre of one of the triangular phosphor groups. The shadow mask fitted in a 63cm tube has about 400,000 of these perforations. As the three electron beams are deflected by the scanning circuitry, they

converge together at the shadow mask holes (Fig.5a).

Fig.5b shows how the electron beams are reduced in size by the shadow mask. The phosphor dots are placed very close to each other, each individual dot having a diameter of 0.25mm. There are three of these dots (one red, one green and one blue) for each individual hole in the shadow mask, giving a total of over one million dots.

The function of the shadow mask is to prevent each separate beam of electrons from "spilling over" and energising more than one dot. The other two dots in the triangle lie in the shadow of the mask, hence the term "shadow mask".

Colour purity

Various adjustments are needed in the television receiver so that the red, green and blue rasters of the delta-gun tube will be in proper registration with each other, appearing to the eye as a single raster. To achieve this it is essential that the red raster is pure red, the blue raster pure blue, and the green raster pure green.

This means that the three electron beams must be deflected at their correct apparent deflection centres and pass through the holes in the shadow mask perforations to strike the proper "colour" phosphor dots. Due to small manufacturing production differences in individual picture tubes, compensating adjustments are needed. These colour correction adjustments are usually referred to as purity adjustments.

If you look again at Fig.4 you'll notice on the neck of the tube the purity magnet assembly, which consists of two magnetised rings which can be independently rotated. These produce a weak magnetic field that can be altered in strength and direction to bend the three electron beams together so that they pass through the correct perforations in the metal shadow mask.

Even so, some phosphor dots of the wrong colour may still be energised at the edge of the screen, this time due to manufacturing variations in the scanning deflection coils etc. When this occurs, the scanning coils can be moved up and down the tube neck to obtain correct purity at the edges of the picture.

Before adjusting the purity, the green and blue electron guns are first switched off. Adjustment of the purity magnets and scanning coils is then repeated several times until the purest possible red raster is obtained. When the blue and green rasters are subsequently viewed separately, they should also now be pure in colour.

That is not the end of the story, however. Although the three rasters may now be pure in colour, the three electron beams may not necessarily enter the same perforations in the shadow mask as they scan across the picture tube. The result is a picture with colour fringes, or even three separate pictures not in registration with each other.

To correct this condition, a convergence assembly containing three adjustable permanent magnets, together with coils energised by electrical currents derived from the television receiver circuitry, is fixed on the neck of the picture tube. Inside the tube are pole pieces through which the three electron beams pass. Each of the three adjustable permanent magnets acts on one set of pole pieces in the picture tube. By adjusting the magnets the individual beams can be moved as shown in Fig.6.

Mounted on the tube neck, between the purity magnets and the picture tube base, is the blue lateral magnet. This adjustable magnet moves the blue electron beam horizontally, to the point where the red and blue beams cross.

These static magnetic adjustments control convergence at the centre of the picture so that the three rasters merge as one. However, because the electron beams are deflected both horizontally and vertically by circuitry in the colour television receiver, misconvergence will still be seen at the top, bottom and sides of the picture. To correct this condition, dynamic convergence adjustments are provided that control currents passed through the coils in the convergence assembly.

We'll discuss how these currents are produced and controlled in a later article in this series.

Another source of colour problems is the shadow mask itself. Because it is made of steel, it can become magnetised and ruin the purity of the picture by producing patches of incorrect colour on the screen. To prevent this, a magnetic shield containing a coil is fitted on the outside of the cone of the picture tube.

This coil is known as a degaussing coil. It is arranged so that, whenever the receiver is switched on, an alternating current at mains frequency passes through the coil for a short period of time. The resulting alternating magnetic field produced by the coil demagnetises (or degausses) the metal shadow mask. The current then gradually dies away.

The colour picture

The three preset controls, VR1, VR2 and VR3 shown in Fig.3, can be adjusted to control the relative intensities of the red, green and blue electron beams so that the eye sees a white raster at maximum brightness.

The "Y" or luminance signal is supplied to the three cathodes of the shadow mask picture tube by the receiver circuitry. Thus, the intensity of all three beams at each point on the tube raster is controlled by the received brightness signal from the TV studio camera via the television transmitter, transmission path and TV receiver. Because the receiver raster scanning is synchronised with the camera scan, a black and white picture will be seen in the case of a monochrome transmission.

When a colour broadcast is received, the detail or brightness signal is produced as for a monochrome transmission. In addition, signal voltages proportional to the red, blue and green colouring are applied individually to the three control grids of the picture tubes, thus descreasing or increasing the brightness of each of the three electron beams.

If we view a discrete area in the picture which is pure green, the red and blue electron beams will be completely cut off in that area of the scan. As varying intensities of the beams occur according to the received colour signals, mixtures of red, blue and green are produced so that the viewer sees a wide

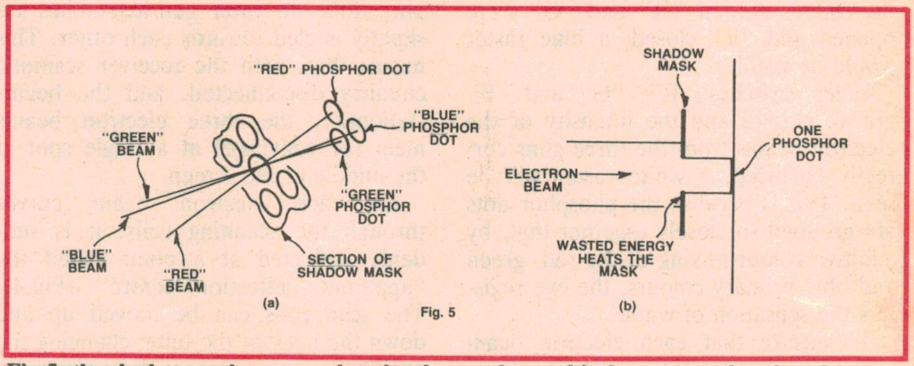


Fig.5: the shadow mask ensures that the electron beams hit the correct phosphor dots.

range of colours. Because these colour areas and the detail of the luminance signal are combined, a complete colour picture is produced.

This method of driving the colour picture tube is known as colour difference drive and was used in early colour receivers.

Practically all modern receivers use RGB drive. With RGB drive, the luminance signal drives all three cathodes as in the colour difference drive method. However, the three signal voltages proportional to the red, blue and green colouring of the picture are supplied, not to the control grids of the tube, but individually to each cathode.

Brightness variations still produce the detail of the picture, but the red, blue and green signal voltages now control the relative values of the cathode voltages, varying the relative intensities of the three electron beams. As in the colour difference drive method, a mixture of red, blue and green hues combined with the monochrome signal produces the complete colour picture.

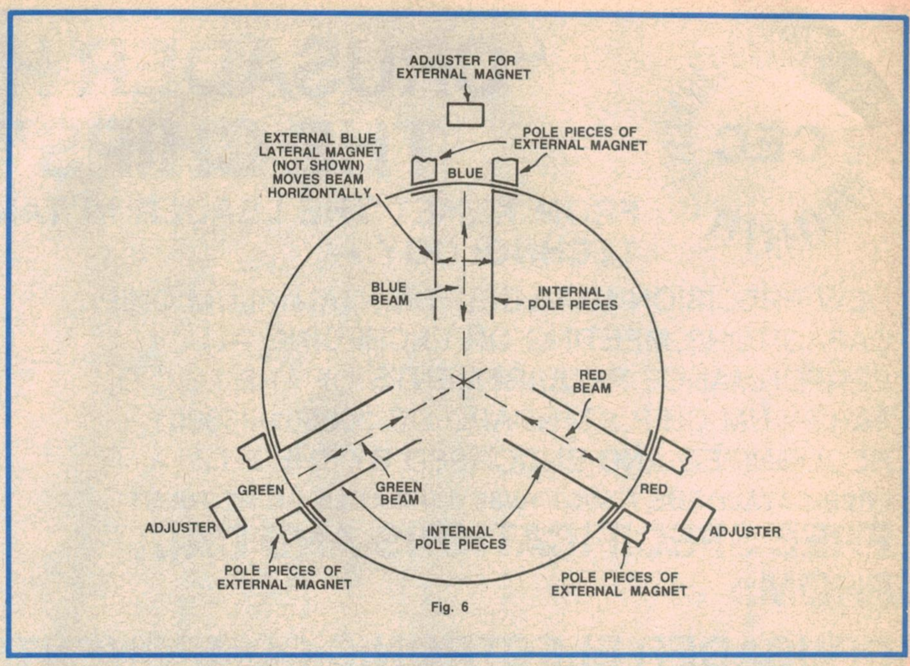


Fig.6: convergence of the red, green and blue rasters at the centre of the screen is achieved by adjusting the external magnet assemblies.

Drawbacks

Although the delta-gun shadow mask tube is capable of displaying excellent monochrome and colour pictures, it does have drawbacks. Look again at Fig.5b and you will see that the shadow mask absorbs a great deal of energy as the electron beams strike it — energy which is wasted in heating up the metal of the mask.

After a period of use this heating effect may cause the shadow mask plate to warp, or even to become loose, making it impossible to obtain correct purity.

Another problem is caused by the shadow mask. It reduces the size of the electron beams and so the picture brightness is also reduced. To overcome this problem, an extra high tension supply (EHT) of 25 kilovolts is required for the final anode of a 63cm picture tube. This accelerates the electron beams to a velocity of 321,800 kilometres per hour with a maximum beam current of one milliamp. This high voltage makes the electron beams more difficult to deflect so that increased energy must be supplied to the scan coils.

An electrical shock from this EHT supply is very dangerous and could prove fatal. This is so even after the colour TV receiver is switched off, because the internal capacitance of the shadow mask tube may retain a high voltage charge for a considerable period of time.

A further problem is that, after some use, the complex purity and convergence adjustments tend to drift and must be reset.

Since the invention of the original shadow mask tube, several new types of picture tubes have been developed. Let's take a quick look at how they operate.

The Trinitron

Sony Corporations's Trinitron tube was first produced in 1968 and has been improved over the years. It employs a single in-line gun that emits three electron beams, each beam being emitted from it's own individual cathode. Fig.7 shows the basic arrangement of Sony's latest Trinitron tube (using their new PanFocus Gun"). RGB drive circuitry is employed.

Because a single gun is used, a much smaller and sharper spot size is possible, giving greatly improved resolution. And instead of a shadow mask having thousands of circular perforations, Sony use a special "aperture grille" system.

The use of this grille results in a much brighter picture. As in the shadow mask tube three kinds of phosphor are deposited inside the tube faceplate. However, in the Trinitron tube, these are arranged, not as triangular dot groups, but as vertical colour stripes.

Further advantages of the Trinitron picture tube are excellent purity and convergence without the need for the complex adjustments required by the

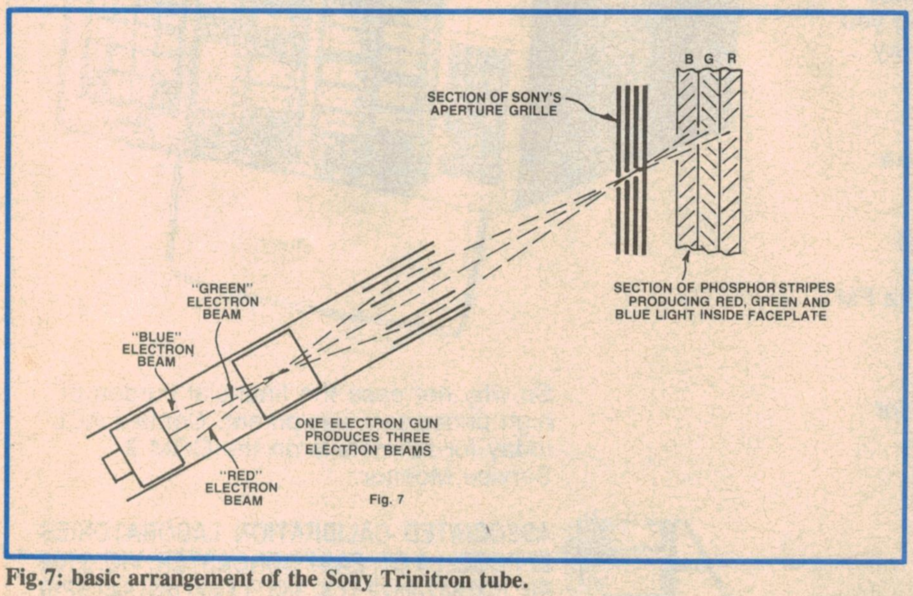


Fig.7: basic arrangement of the Sony Trinitron tube.

shadow mask tube. Static convergence controls move the two outside electron beams to meet the middle beam, then simple dynamic adjustments are made.

In-line tubes

This type of tube has three electron guns but, instead of being arranged in delta formation, they are arranged in a horizontal in-line configuration. The tube neck is fitted with specially designed deflection coils, while the shadow mask uses slotted holes. The colour phosphors inside the faceplate are in stripe formation.

This type of tube is capable of producing a brighter picture than the older delta-gun configuration, due to the slotted shadow mask which blocks less of the electron beams. Because of this, some type of slotted shadow mask is now used in most modern colour TV tubes. The main exception is, of course, the Sony Trinitron tube.

One modern tube, the Philips 20AX, uses three in-line electron guns, is made to extremely accurate tolerances, and requires only minor convergence adjustments. But even these adjustments are unnecessary with the Philips 30AX tube which features specially designed self-locating scan coils, and internal factory set magnets fitted within the tube.

The very latest development is the FST tube. It features a virtually flat tube face constructed of extra thick glass, and has much squarer corners than conventional tubes. It also uses in-line guns, the exception being the latest Mullard/Philips 45AX version which has a three-beam single gun.

Projection TV

To obtain large size pictures, projection television systems are used. In these, three special projection picture tubes, each with a different colour face phosphor, and operated at very high final anode voltages, are fitted. The red, green and blue colour signal voltages, together with the luminance signal, are fed separately to each tube.

The three pictures are combined optically and the resulting colour picture is projected on to a screen. Customer preferred screen sizes are 90 to 94 centimetres (measured diagonally). It is best to view the picture in subdued room lighting due to inherent brightness limitations.

Liquid crystal displays

A liquid crystal display, as used in a watch or calculator etc, contains so-called nematic liquids which are normally transparent. When subjected to an electric field, however, they become opaque.

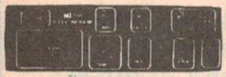
To construct a liquid crystal display that will produce a television picture, a screen containing thousands of tiny liquid crystal elements is used. The received luminance signal controls the brightness of each point of the display so that a monochrome picture can be viewed. You have probably seen, or may own, a pocket monochrome TV set featuring a liquid crystal display. External lighting or a back light is needed to see the picture.

Large sums of money are at present being invested by television manufacturing companies to try to produce a practical large flat colour display suitable for use in TV receivers.

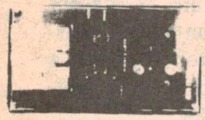
Fitting different colour filters over each tiny crystal of an LCD display is a future possibility. By this means, variations in brightness and colour intensity between the tiny picture elements would cause the eye to see a colour picture. Another method is to use combinations of LCDs, each display producing one of the primary colours. Projection TV using this idea is under development.

In the fifth article in this series we'll consider the operation of the colour decoder in a PAL receiver and how it handles the U and V signals. EA

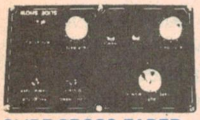
SPECIALS!



COMPUTER DRIVEN RADIO-TELETYPE TRANSCEIVER KIT
Here's what you've been asking for, a full trasmit-receive system for computer driven radio teletype station. The software provides all the latest "whizz-bangs" like split-screen operation, automatically repeating test message, printer output and more. The hardware uses tried and proven techniques. While designed to team with the popular Microbee, tips are avaialble on interfacing the unit to other computers. (ETI Nov.'84) ETI 755)
Cat. K47550 .... Normally $135
SPECIAL, $99



LOW OHMS METER
How many times have you cursed your Multimeter when you had to measure a low-value resistance? Well with the "Low Ohms Meter" you can solve those old problems and in fact measure resistance from 100 Ohms down to 0.005 Ohms.
(ETI Nov.'81) ETI 158
Cat. K41580 .... Normally $39.50
SPECIAL, $34.50



SLIDE CROSS-FADER
Want to put on really professional slide show? This slide cross-fader can provide smooth dissolves from one projector to another, initiate slide changing automatically from an in-built variable timer, and synchronise slide changes to pre-recorded commentary or music on a tape recorder. All this at a cost far less than comparable commercial units. (EA Nov.'81) 81SS11
Cat. K81110 .... Normally $99.00
SPECIAL, $89.00

30 V/1 A FULLY PROTECTED POWER SUPPLY
The last power supply we did was the phenomenally popular ETI-131. This low cost supply features full protection, output variation from 0V to 30V and selectable current limit. Both volatage and current metering is provided. (ETI Dec.'83) ETI 162
Cat. K41620 .... Normally $69.50
SPECIAL, $59.50

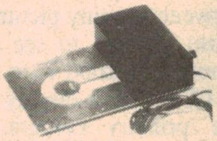
MULTI SECTOR ALARM STATION
Protect your home and possessions from burglars with this up to the minute burglar alarm system. It's easy to build, costs less than equivalent commercial units, and features eight seperate inputs, individual sector control, battery back up and self-test facility.
Specifications:
- Eight sectors with LED status indication
- Two delayed entry sectors
- Variable exit, entry and alarm time settings: entry delay variable between 10 and 75 seconds; exit delay variable between 5 and 45 seconds; alarm time variable between 1 and 15 minutes
- Resistive loop sensing: suits both normally open and normally closed alarm sensors
- Battery back-up with in-built charger circuit
- Built-in siren driver

The RIE kit includes a superb printed and prepunched metal case and inside metal work, plus a gell battery! Unbeatable VALUE!
K85900 complete kit ...... only $159
K85901 without battery backup $134

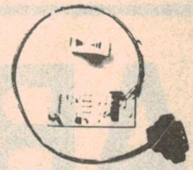
15V DUAL POWER SUPPLY
This simple project is suitable for most projects requiring a dual voltage. Includes transformer. (ETI 581, June '76)
Cat. K45810 .... $34.95

50 W AMPLIFIER MODULE (ETI 480)
Cat. K44880 .... $29.50
(Heatsink optional extra)

100 W AMPLIFIER MODULE (ETI 480)
Cat. K44801 .... $34.50
(Heatsink optional extra)

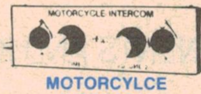


ELECTRONIC MOUSETRAP
This clever electronic mousetrap disposes of mice instantly and mercifully, without fail, and resets itself automatically. They'll never get away with the cheese again!
(ETI Aug.'84) ETI 1524
Cat. K55240 .... $39.95

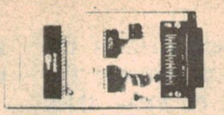


RADIOTELETYPE CONVERTER FOR THE MICROBEE
Have your computer print the latest news from the international shortwave news service. Just hook up this project between your short wave receivers audio output and the MicroBee parallel port. A simple bit of software does the decoding. Can be hooked up to other computers too. (ETI Apr.'83)
Cat. K47330 .... $19.95

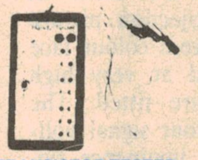
MUSICOLOR IV
Add excitement to parties, card nights and discos with EAs Musicolor IV light show. This is the latest in the famous line of musicolors and it offers features such as four channel "color organ" plus four channel light chaser, front panel LED display, internal microphone, single sensitivity control plus opto-coupled switching for increased safety.
(EA Aug.'81) 81MC8
Cat. K81080 .... $99



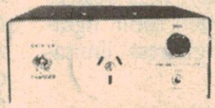
MOTORCYLCE INTERCOM
OVER 500 SOLD!
Motorcycling is fun, but the conversation between rider and passenger is usually just not possible. But build this intercom and you can converse with your passenger at any time while you are on the move. There are no "push-to-talk" buttons, adjustable volume and it's easy to build!
(EA Feb.'84) 84MC2
Cat. K84020 .... $49.95



MICROBEE SERIAL-TO-PARALLEL INTERFACE
Most microcomputers worth owning have an 'RS232' connector, or port, through which serial communications (input/output) is conducted. It is a convention that, for listing on a printer, the BASIC LLIST or LPRINT command assumes a printer is connected to the RS232 port. Problem is, serial interface printers are more expensive than parallel 'Centronics' interface printers. Save money by building this interface. (ETI Jan.'84) ETI 675
Cat. K46750 .... $39.50

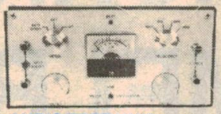


TRANSISTOR TESTER
Have you ever desoldered a suspect transistor, only to find that it checks OK? Trouble-shooting exercises are often hindered by this type of false alarm, but many of them could be avoided with an "in-circuit" component tester, such as the EA Handy Tester. (EA Sept.'83) 83TT8
Cat. K83080 .... $18.95



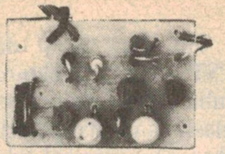
12/240V 40W INVERTER
This 12 240V inverter can be used to power up mains appliances rated up to 40W, or to vary the speed of a turntable. As a bonus, it will also work backwards as a trickle charger to top up the battery when the power is on. (EA May'82) 82IV5
Cat. K82050 .... $69.95

ELECTRIC FENCE CONTROLLER
Restore discipline to the farm or allotment with this new electric fence controller. It features higher output power and lower current drain than the previous design for use in rural areas.
(EA Dec.'85, 85ef11)
Cat K85110 .... $49.95

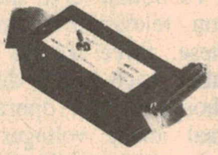


AUDIO TEST UNIT
Just about everyone these days who has a stereo system also has a good cassette deck, but not many people are able to get the best performance from it. Our Audio Test Unit allows you to set your cassette recorder's bias for optimum frequency response for a given tape or alternatively, it allows you to find out which tape is best for your recorder. (81AO10) (EA Oct.'81)
Cat. K81101 .... $59.50

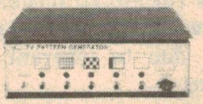
VIDEO FADER CIRCUIT
Add a touch of professionalism to your video movies with this simple Video Fader Circuit. It enables you to fade a scene to black (and back again) without loss of picture lock (sync) or colour.
(EA Jan.'86, 85ff10)
Cat K86010 .... Normally $24.95
Special, only $19.95



LOW BATTERY VOLTAGE INDICATOR
Knowing your batteries are about to give up on you could save many an embarrassing situation. This simple low cost project will give your early warning of power failure, and makes a handy beginner's project.
(ETI 280, March '85)
Cat. K42800 .... $9.95



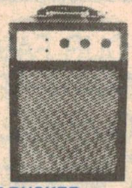
PARALLEL PRINTER SWITCH KIT
Tired of plug swapping when ever you want to change from one printer to another? This low-cost project should suit you down to the ground. It lets you have two Centronics-type printers connected up permanently, so that you can select one or the other at the flick of a switch.
(ETI 666, Feb.'85)
Cat. K46660 .... $79.95



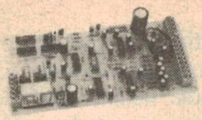
CRYSTAL CONTROLLED TV PATTERN GENERATOR
Anyone wishing to obtain the maximum performance from a colour TV reciever needs a pattern generator. Why not build this superb unit which provides five separate patterns; dot, crosshatch, checker board, grey scale and white raster?
Note: The RIE kit includes a large ABS type case!
(80pg6, EA June '80)
Cat. K80033 .... $97.50

HUMIDITY METER
This project can be built to give a readout of relative humidity either on a LED dot-mode display or a conventional meter. In addition it can be used with another project as a controller to turn on and off a water mist spray in a hothouse, for example. (ETI May '81) ETI-256
(Includes humidity sensor $19.50)
Cat. K42560 .... $49.95

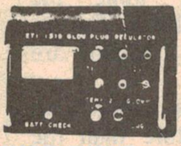
STEREO ENHANCER
The best thing about stereo is that it sounds good! The greatest stereo hi-fi system loses its magnificence if the effect is so narrow you can't hear it. This project lets you cheat on being cheated and creates an 'enhanced stereo effect' with a small unit which attaches to your amp.
(ETI 1405, ETI, MAR '85)
Cat. K54050 .... $79.50



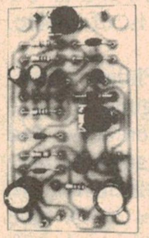
THE BUSKER PORTABLE AMPLIFIER
This handy amplifier is completely portable and is capable of operating from either the mains or a 12V battery. Main features include guitar and high-level inputs, an inbuilt loudspeaker, and bass and treble controls. Its just the thing for busking or for guitar practice
(EA Feb.'85 85ba2)
Cat K85020 (excluding cabinet) $99



DELUXE CAR BURGLAR ALARM
Stop your car from being one of the 70,000+ stolen cars stolen each year with this "state of the art" car burglar alarm. Features include key switch operation, delayed entry and exit, automatic reset, and provision for an auxiliary battery. Further more, of the 10 most important features listed by NRMA, this EA Deluxe Car Alarm has 9 of them!
(84ba5, EA May '84)
Cat. K84050 .... $99.50

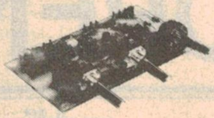


MODEL ENGINE IGNITION SYSTEM
Get sure starts every time, without glow plug burnouts on your model engines.
(ETI June'83) ETI 1516
Cat. K55160 .... $49.50



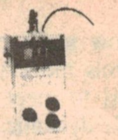
1W AUDIO AMPLIFIER
A low-cost general-purpose, 1 watt audio amplifier, suitable for increasing your computers audio level, etc. (EA Nov.'84)
Cat. K84111 .... $9.95

ZENER TESTER
A simple low cost add-on for your multimeter. This checks zeners and reads out the zener voltage directly on your multimeter. It can also check LEDs and ordinary diodes.
(ETI May'83) ETI 164
Cat. K41640 .... $11.95

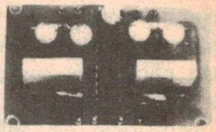


PREAMP FOR PAGING AMP
A versatile preamp with separate bass, treble and volume. (ETI 1421)
Cat. K54210 .... $24.95

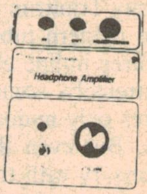
FAIR DINKUM RS232 FOR MICROBEE
The Microbee, among other home computers, has a 'sort of' RS232 port in that it doesn't implement negative-going portion of its output signal (TxD). Most peripherals with an RS232 input can cope with that but inevitably, there are those that can't. This project fixes that
(ETI 676, ETI FEB '84)
Cat. K46760 .... $39.50



PH METER KIT
Build this pH meter for use with swimming pools to fish tanks to gardening, this pH meter has many applications around the home. This unit features a large $3\frac{1}{2}$ digit liquid crystal display and resolution to .01 pH units, making it suitable for use in the laboratory as well.
(EA Dec.'82) 82PH12
Cat. K82123 .... $199

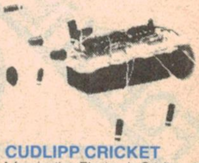


GENERAL PURPOSE AMPLIFIER CLASS B
One of the handiest 'tools' for the electronics experimenter is a genuine purpose audio amp. This module will work from a wide range of supply voltages, has good sensitivity, is robust and reliable - easy to build too! (ETI 453)
(ETI April '80)
Cat. K44530 .... $14.95



HEADPHONE AMPLIFIER
PRACTICE WITHOUT ANNOYING THE FAMILY!
If you play any type of electronic instrument, this headphone amplifier will surely interest you. It will let you practice for hours without upsetting the household, or you can use it to monitor your own instrument in the midst of a rowdy jam session. (EA Feb.'84) 83MA11
Cat. K84111 .... $29.95

EA AM STEREO DECODER
AM stereo is now broadcast in Australia on an experimental basis. This add-on decoder works with the Motorola C-QUAM system.
(EA Oct.'84) 84MS10
Cat. K84100 .... $26.95



CUDLIPP CRICKET
A fascinating Electronic Cricket with just two ICs. The Cudlipp can be used to bug your home, office etc! Great fun! (EA Feb.'82) 82EG2
Cat. K82022 .... $12.95

PARABOLIC MICROPHONE
Build a low cost parabola, along with a high gain headphone amplifier to help when listening to those natural activities such as babbling brooks, singing birds or perhaps even more sinister noises. The current cost of components for this project is around $15 including sales tax, but not the cost of batteries or headphones. (EA Nov '83) 83MA11
Cat. K83110 .... $14.95

SERIES 5000

INDIVIDUAL COMPONENTS TO MAKE UP A SUPERB HIFI SYSTEM!

By directly importing and a more technically orientated organisation, ROD IRVING ELECTRONICS can bring you these products at lower prices than their competitors. Enjoy the many other advantages of RIE Series 5000 kits such as "Superb Finish" front panels at no extra cost, top quality components supplied throughout. Over 1,500 sold!
For those who haven't the time and want a quality hi-fi, we also sell the Series 5000 kits assembled and tested.

POWER AMPLIFIER

WHY YOU SHOULD BUY A "ROD IRVING ELECTRONICS" SERIES 5000 POWER AMPLIFIER

- 1% Metal Film resistors

SPECIAL, ONLY $399
SAVE $50

... and developed by ... ELECTRONICS and is being supplied to other kit suppliers.

SPECIFICATIONS: 150 W RMS into 4 ohms (per channel)
POWER AMPLIFIER: 100W RMS into 8 ohms (+ −55V Supply)
FREQUENCY RESPONSE: 8Hz to 20Hz +0=0.4 dB 2.8Hz to 65KHz, +0=3 dB. NOTE: These figures are determined solely by passive filters.
INPUT SENSITIVITY: 1 V RMS for 100W ouput.
HUM: 100 dB below full output (flat).
NOISE: 116 dB below full output (flat, 20KHz bandwidth).
2nd HARMONIC DISTORTION: ‹0.001% at 1 KHz (0.0007% on Prototypes) at 100W ouput using a + =56V SUPPLY rated at 4A continues ‹0.0003% for all frequencies less than 10KHz and all powers below clipping.
TOTAL HARMONIC DISTORTION: Determined by 2nd Harmonic Distortion (see above).
INTERMODULATION DISTORTION: 0.003% at 100W. (50Hz and 7KHz mixed 4:1).
STABILITY: Unconditional.

Cat. K44771 .... **$449**
Assembled and tested $599
packing and post $10

PREAMPLIFIER

THE ADVANTAGES OF BUYING A "ROD IRVING ELECTRONICS" SERIES 5000 PREAMPLIFIER

- 1% Metal Film ...

SPECIAL, ONLY $359
SAVE $40

... believe that dollar for ... commercial unit available that sounds as ...

SPECIFICATIONS:
FREQUENCY RESPONSE: High-level input: 15Hz = 130KHz, +0.=1dB Low-Level input-conforms to RIAA equalisation + = 0.2dB
DISTORTION: 1KHz ‹0.003% on all inputs (limit of resolution on measuring equipment due to noise limitation).
S/N NOISE: High-Level input, master full, with respect to 300mV input signal at full output (1.2V) ›92dB flat ›100dB A-weighted, MM input, master full, with respect to full output (1.2V) at 5 mV input 50ohms source resistance connected: ›86dB flat/92dB A-weighted MC input, master full, with respect to full output (1.2V) and 200uV input signal: ›71dB flat ›75dB A-weighted.

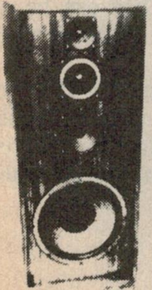
Cat. K44791 .... **$399**
Assembled and tested $699
packing and postage $10

THIRD OCTAVE GRAPHIC EQUALIZER

SPECIFICATIONS:
BANDS: 28 Bands ...

SPECIAL, ONLY $209
SAVE $30

Cat. K44590 .... 1 unit: **$239**
.... 2 units: **$429**
packing and postage $10



SERIES 4000 SPEAKERS

8 Speakers .... **only $549**
8 Speakers with Crossovers .. **$795**
Speaker Cabinet Kit (complete) **$395**
(Please specify cabinet to suit 7" or 8" mid range woofer)
Crossover Kits **$295**
Complete kit of parts (speakers, crossovers, screws, innerband boxes.) **$1,095**
Assembled, tested and ready to hook up to your system ... $1,295
(Approximately 4 weeks delivery)

Errors and Ommissions Excepted

VIFA/AEM 3 WAY SPEAKER KIT!

This superb 3 way speaker kit competes with systems that cost 2 - 3 times the cost of these units! (which may even be using VIFA drivers etc.) Never before has it been possible to get such exceptional value in kit speakers! Call in personally and compare for yourself!

The system comprises...
2 x D19 dome tweeters
2 x D75 dome midrange
2 x P25 woofers
2 x pre-built quality crossovers

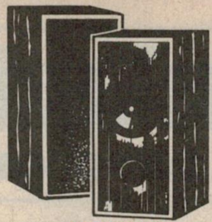
The cabinet kit consists of 2 knock-down boxes in beautiful black grain look with silver baffles, speaker cloth, innerbond, grill clips, speaker terminals, screws and ports.

D19 DOME TWEETER SPEAKER SPECIFICATIONS
Nominal Impedance: 8 ohms
Frequency Range: 2.5 - 20kHz
Free Air Resonance: 1,700Hz
Sensitivity 1W at 1m: 89dB
Nominal Power: 80 Watts
(fo: 5,000Hz, 12dB/oct)
Voice Coil Diameter: 19mm
Voice Coil Resistance: 6.2ohms
Moving Mass: 0.2 grams
Weight: 0.28kg

D75 DOME MIDRANGE SPECIFICATIONS:
Nominal Impedance: 8 ohms
Frequency Range: 350 - 5,000Hz
Free Air Resonance: 300Hz
Sensitivity (1W at 1m): 91dB
Nominal Power: 80 Watts
(fo: 500Hz, 12dB/oct)
Voice Coil Diameter: 75mm
Voice Coil Resistance: 7.2ohms
Moving Mass (incl. air): 3.6 grams
Weight: 0.65kg

P25 WOOFER SPECIFICATIONS:
Nominal Impedance: 8 ohms
Frequency Range: 25 - 3,000Hz
Free Air Resonance: 25Hz
Operating Power: 5 watts
Sensitivity (1W at 1m): 89dB
Nominal Power: 60 Watts
Music Power: 100 Watts
Voice Coil Diameter: 40mm
Voice Coil Resistance: 5.7ohms
Moving Mass (incl. air): 44 grams
Thiele/Small Parameters:
Qm: 3.15
Qe: 0.46
Qt: 0.40
Vas: 180:1
Weight: 1.95kg

Complete Kit Cat.K16030 **$1,199**
Speaker Kit Cat.K16031 .. **$949**
Cabinet Kit Cat.K16032 ... **$349**



VIFA/AEM 2 WAY SPEAKER KIT!

This exciting new speaker kit, designed by David Tillbrook (a name synonymous with brilliant design and performance) uses VIFA's high perfomance drivers from Denmark. You will save around $800 when you hear what you get from this system when compared to something you buy off the shelf with similar characteristics. Call in personally and compare for yourself!

The system comprises...
2 x P21 Polycone 8" woofers
2 x D25T Ferrofluid cooled dome tweeters with Polymer diaphrams
2 pre-built quality crossovers

The cabinet kit consists of 2 knock-down boxes in beautiful black grain look with silver baffles, speaker cloth, innerbond, grill clips, speaker terminals, screws and ports.

D25T SPEAKER SPECIFICATIONS
Nominal Impedance: 6 ohms
Frequency Range: 2 - 24kHz
Free Air Resonance: 1500Hz
Operating Power: 3.2 watts
Sensitivity (1W at 1m): 90dB
Nominal Power: 90 Watts
Voice Coil Diameter: 25mm
Air Gap Height: 2mm
Voice Coil Resistance: 4.7ohms
Moving Mass: 0.3 grams
Weight: 0.53kg

P21 WOOFER SPECIFICATIONS:
Nominal Impedance: 8 ohms
Frequency Range: 26 - 4,000Hz
Free Air Resonance: 33Hz
Operating Power: 2.5 watts
Sensitivity (1W at 1m): 92dB
Nominal Power: 60 Watts
Voice Coil Diameter: 40mm
Voice Coil Resistance: 5.8ohms
Moving Mass: 20 grams
Thiele/Small Parameters: Qm: 2.4
Qe: 0.41
Qt: 0.35
Vas: 80:1
Weight: 1.65kg

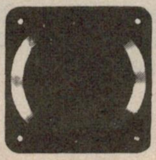
Complete Kit Cat.K16020 ... **$799**
Speaker Kit Cat.K16021 ... **$649**
Cabinet Kit Cat.K16022 ... **$209**

NEW!! DIRECT IMPORT!!

MULTI FUNCTION STEREO MIXER EQUALIZER

SPECIFICATIONS:
SENSITIVITY:
Phono: 3mV
Mic: 1mV
Line (tape or tuner): 150mV
SIGNAL/NOISE RATIO:
Phono: 55dB
Mic: 60dB
Line: 65dB
FREQUENCY:
Phono: 20Hz-20KHz (RIAA + − 2dB)
Mic: 20Hz-20KHz + − 3dB
Line: 20Hz-20KHz + − 3dB
CHANNEL BALANCE: 0.5dB
T.H.D: Less than 0.03%
HEADPHONE IMPEDANCE: 4-16 ohms
OUTPUT: 0.775V
EQUALIZER:
Centre frequency: 60Hz, 250Hz, 1KHz, 4KHz, 12KHz
Control Gain: + − 12dB
POWER SOURCE: 110V/60Hz or 220V/50Hz

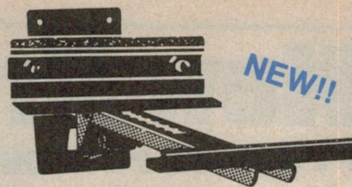
Cat.A12016 .... Normally $399
SPECIAL, ONLY $349



PHILIPS SPEAKERS

Description	Cat.No.	Price
AD01610T8	(C12030)	$24.95
AD02160SQ8	(C12040)	$69.95
AD80652W8	(C12042)	$69.95
AD070620M8	(C12045)	$69.95
AD12250W8	(C12050)	$129.00

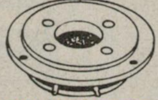
NEW!!



WALL MOUNTING SPEAKER HOLDERS

Mount your speakers at ear level on your wall!!
Features....
- Holds speakers up to 260mm deep
- Left/Right adjustment
- Up/Down adjustment
- Includes mounting screws
- Nipping-screw pins hold speakers firmly in place
- Installation instructions

Cat. **$89.95**

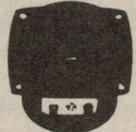


1" DOME TWEETER SPEAKER

Mylar diaphragm
SPECIFICATIONS:
Sensitivity: 96dB
Frequency Response: 2-20 kHz
Impedance: 8 ohms
Power RMS: 15 watts RMS
Magnet Weight: 5.4cz.
Size: 96mm diameter
Cat. C10234 .... **$10.95**

8" WOOFER HIGH POWER SPEAKER

Cloth edge, dark grey cone, rubber mounting seal, cloth dust cap.
SPECIFICATIONS:
Sensitivity: 90dB
Frequency Response: 60-4 kHz
Impedance: 8 ohms
Power RMS: 50 watts RMS
Magnet Weight: 20oz.
Cat. C10226 .... **$34.95**



2" HORN TWEETER SPEAKER

Mylar diaphragm, aluminium voice coil
SPECIFICATIONS:
Sensitivity: 95dB
Frequency Response: 1.5-20 kHz
Impedance: 8 ohms
Power RMS: 10 watts RMS
Magnet Weight: 2.5oz.
Cat. C10232 .... **$8.95**

8" TWIN CONE FULL RANGE SPEAKER

Foam edge, black cone, black whizzer cone
SPECIFICATIONS:
Sensitivity: 98dB
Frequency Response: 45-16 kHz
Impedance: 8 ohms
Power RMS: 30 watts RMS
Magnet Weight: 13oz.
Cat. C10224 .... **$23.95**

MAIL ORDER HOTLINE
008 335757
(TOLL FREE)
LOCAL: 543 7877

rie
Rod Irving Electronics
48 A'Beckett St, MELBOURNE
Phone (03) 663 6151
425 High St, NORTHCOTE
Phone (03) 489 8866
Mail Order and Correspondence:
P.O. Box 620, CLAYTON 3168
Telex: AA 151938

5" MIDRANGE SPEAKER

Sealed back, foam edge, black cone, silver dust cap.
SPECIFICATIONS:
Sensitivity: 98dB
Frequency Response: 500-8 kHz
Impedance: 8 ohms
Power RMS: 10 watts RMS
Magnet Weight: 5.4oz.
Cat. C10230 .... **$12.95**

6½" TWIN CONE FULL RANGE SPEAKER

Foam edge, black cone, black whizzer cone
SPECIFICATIONS:
Sensitivity: 89dB
Frequency Response: 60-15 kHz
Impedance: 8 ohms
Power RMS: 10 watts RMS
Magnet Weight: 5.3oz.
Cat. C10222 .... **$14.95**

MAIL ORDER HOTLINE
008 335757
(TOLL FREE)
(STRICTLY ORDERS ONLY)

LOCAL ORDERS & INQUIRIES
(03) 543 7877

POSTAGE RATES:

$1 – $9.99	$2.00
$10 – $24.99	$3.00
$25 – $49.99	$4.00
$50 – $99.99	$5.00
$100 – $199	$7.50
$200 – $499	$10.00
$500 plus	$12.50

FREE POSTAGE FOR ORDERS OVER $75 & UNDER 1KG!!

The above postage rates are for basic postage only. Road Freight, bulky and fragile items will be charged at different rates.

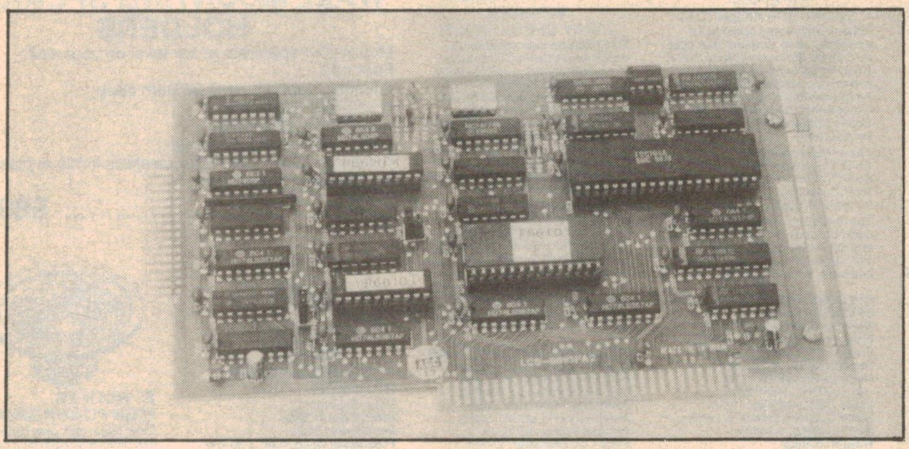
All sales tax exempt orders and wholesale inquiries to:
RITRONICS WHOLESALE,
56 Renver Rd, Clayton.
Ph. (03) 543 2166 (3 lines)

Errors and omissions excepted

MasterCard VISA

New Products...

Product reviews, releases & services

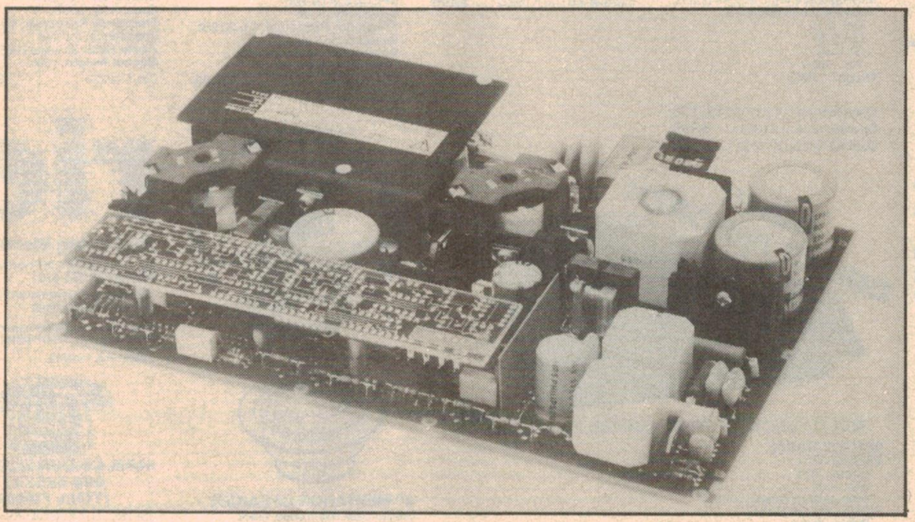


Floppy disc controller

With the release of the 1.2MB/360KB dual standard floppy disc controller, Electronic Solutions has reduced the task of backing up hard discs onto floppies.

The adaptor works in all IBM PCs, ATs and compatibles and allows them to drive any combination of 1.2MB and 360KB drives. With one of these fitted to a PC, it is possible to back up a 10MB hard disc onto only nine floppies instead of 31, or to exchange data with an IBM PC/AT.

For further information contact Electronic Solutions, PO Box 426, Gladesville, NSW 2111. Telephone (02) 427 4422.



Uninterruptible supply from Philips

Philips Test and Measurement has released an uninteruptible DC switcher, Called the PE5270/33, it offers a back-up time of up to 30 minutes for its 5V 6A output if an external 5Ah 12V battery is used.

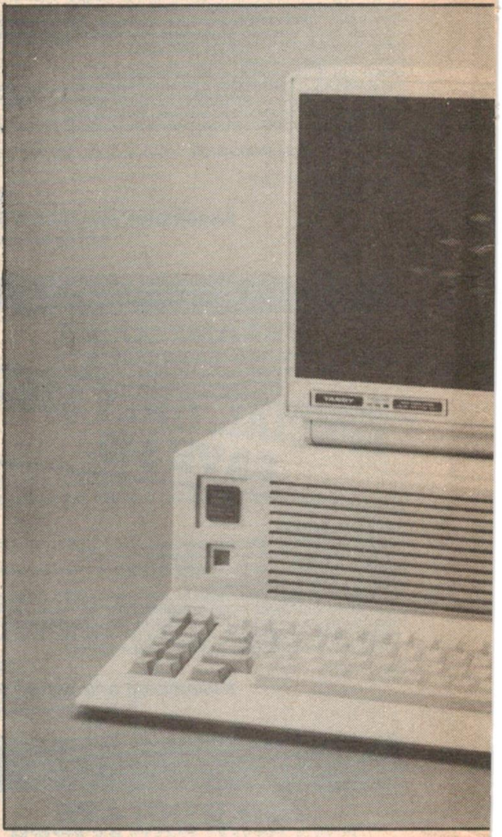
In addition to this back-up voltage output, the unit also provides three other regulated output supplies and logic signals for a computer, including VMEbus commands. The main supply output feeds a built-in charger to trickle-charge the battery. Protection is provided to prevent reversed battery polarity and excessive discharging.

For further information, contact Philips Test and Measurement, 25-27 Paul Street North, North Ryde, NSW 2113. Telephone (02) 888 8222.

Tandy's IBM PC/AT compatible

Tandy has recently released their model 3000HD computer, which is designed as a high-performance low-cost alternative to the IBM PC/AT.

Features of the 3000HD include: Intel 80286 processor with 16-bit data path operating at a speed of 8MHz, 512K of RAM with parity, expandable to 12 megabytes under the XENIX system using the ten expansion slots. Micro soft MS-DOS is optional. For compatibility,



Touch screen feature for computer monitors

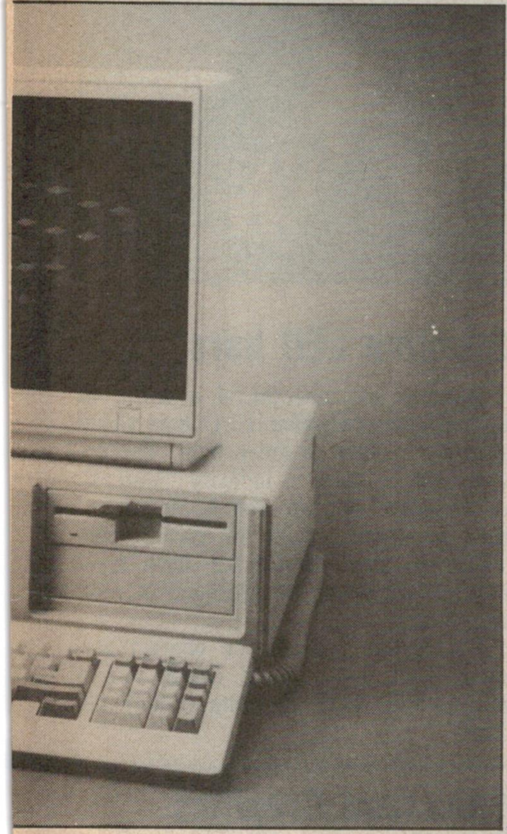
Monex has introduced touch screens as add-on peripherals to Apples, IBM PCs and compatibles. They can be attached to any 23cm to 38cm monitor with Velcro.

Touch screen monitors are ideal for use in situations such as training, public access, entertainment, factory control, education, instrument control and military control.

the 3000HD's built-in high-density 13.3cm thinline floppy disk drive reads 1.2 megabyte and 360K formats for use with IBM PC diskettes.

For maximum storage capacity and fast access to data, the 3000HD also features a built-in 20 megabyte hard disk drive. An 80287 maths co-processor is optional. Recommended retail prices start at $8999.00.

For further information, contact Tandy Electronics at 91 Kurrajong Avenue, Mt. Druitt, NSW 2770. Telephone (02) 675 1222.



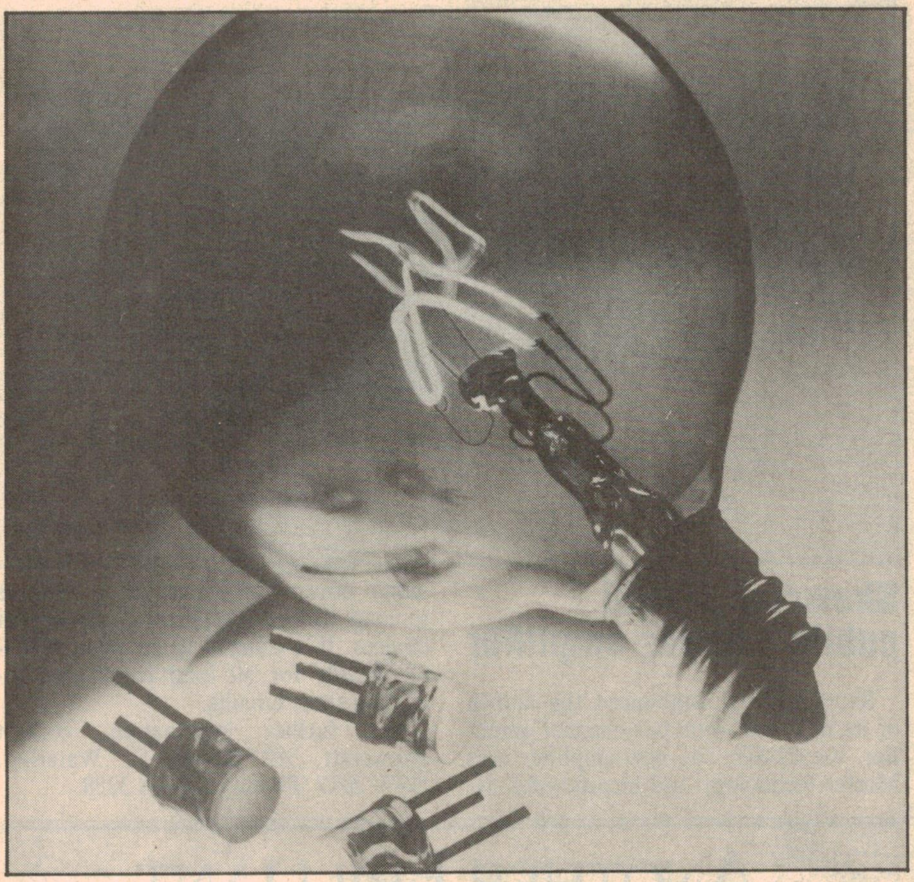
The touch screens are transparent membrane switches with a glass protective backing. The analog interfaced touch screens have a resolution of 256 x 256 on the PC and Apple or 670 x 670 on the PC/AT because of its high clock rate. The RS-232 interfaced screen has a resolution of 256 x 256 on all PCs and compatibles. All the screens have a response time of 7 milliseconds.

For further information contact Monex, 1 Wickham Terrace, Brisbane, Qld. 4000. Telephone (07) 832 0345.

Showcraft P1400 public address amplifier

Showcraft has announced the launch of its new 750 watts per channel amplifier, the P1400. The new amplifier uses Mosfet technology and incorporates dynamic power limiting which is sensitive to load and temperature of the output devices. It is claimed to be unconditionally stable for all load conditions, including short circuits.

For further information, contact Showcraft, 937 Bourke St, Waterloo, NSW 2017. Phone (02) 698 3288.

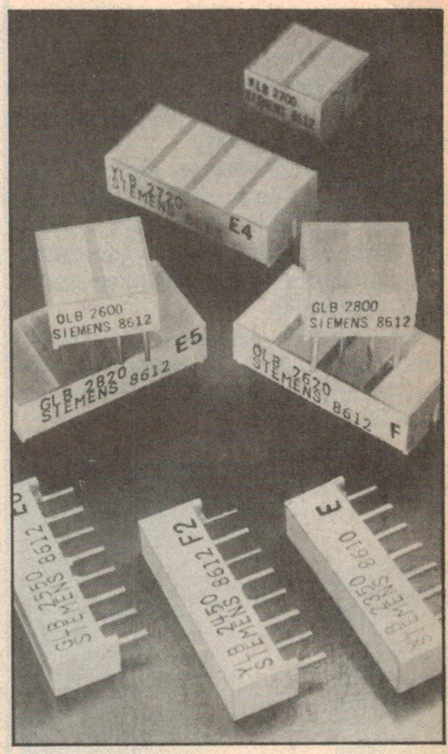


HP LEDs to replace lamps

Hewlett Packard has released a new series of LEDs as an alternative to small incandescent lamps. They are specifically intended for backlighting and are available in three versions: high-efficiency red HLMP-A200, yellow HLMP-A300 and high-performance green HLMP-A500.

Each device features four LED chips. The package design and amount of light radiated from the four chips provide a wide radiation pattern. This allows larger areas to be covered with uniform, bright allumination.

For further information, contact VSI Electronics (Australia) Pty Ltd, 16 Dickson Avenue, Artarmon, NSW 2064. Telephone (02) 439 4655.



Slimline LED bars

Siemens has introduced a range of high-efficiency slimline LED bars which emit red, yellow or green light. The devices can be used to indicate "On/Off" or "Yes/No" and are able to depict letters, numbers, scales or pictographs. They are also suitable for flush front mounting and can be arranged in rows as required.

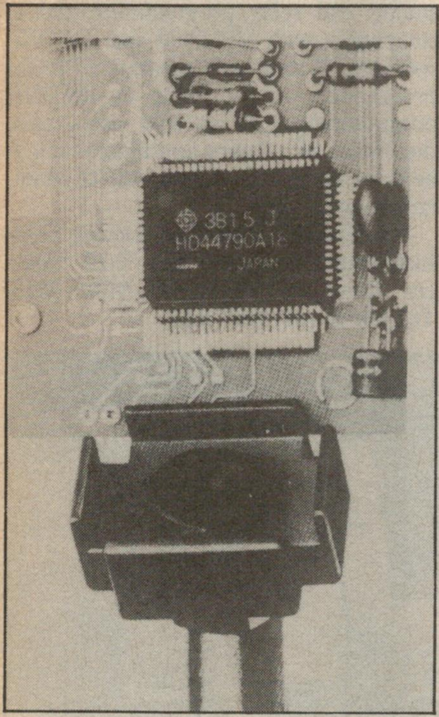
For further information contact Siemens Ltd, 544 Church Street, Richmond, Vic. 3121. Telephone (03) 420 7204.

Enhanced Graphics Adaptor

With the release of the combination Turbo "speed-up" and Enhanced Graphics Card, Electronic Solutions are able to turn an ordinary IBM PC or 8088 based compatible into a very fast 80286 based machine with all the graphics standards.

Electronics Solutions believe it will be attractive to PC owners wanting to run CAD, business and graphic programs at IBM AT speeds.

The card supports all four graphics standards (EGA, CGA, MDA and Hercules Graphics), so existing software can



Desoldering accessories

Weller has introduced a series of effective desoldering accessories which make quick work of flat or quad-pack desoldering without the risk of damaging leads on the circuit board.

A temperature-controlled frame simultaneously melts the solder of all connected leads. Then, the component is gently lifted when the vacuum switch is activated.

For more information, contact George Brown Marketing Divison, 456 Spencer Street, West Melbourne, Vic. 3003. Telephone (03) 329 7500

Pocket transceiver from ICOM

Icom has released the first real pocket transceiver. The palm-sized IC-u2A, measuring just 58 x 140 x 29mm (W x H x D), uses three rocker switches to select frequencies in the range of 144 to 148MHz in steps of 1MHz, 100kHz and 10kHz. Alternatively, by using the UP/DOWN scan button, the IC-u2A will scan the entire band in increments of 5kHz.

The IC-u2A features ten memory channels and the frequency and memory channel in use are indicated on the green liquid crystal display. Frequency coverage is from 144 to 147.995MHz.

The IC-u2A receiver circuit is a dual conversion design with intermediate frequencies of 16.9MHz and 455kHz. It features a multiple-stage FET front end for outstanding sensitivity (less than 0.25uV or –12dBu for 12dB SINAD) and selectivity (more than 60dB rejection of spurious signals).

The transmitter section of the IC-u2A uses a three stage power amplifier circuit to produce 1W RF output (selectable to 0.1W) into a very short, high efficiency, flexible antenna, for a battery drain of 600mA on full transmit.

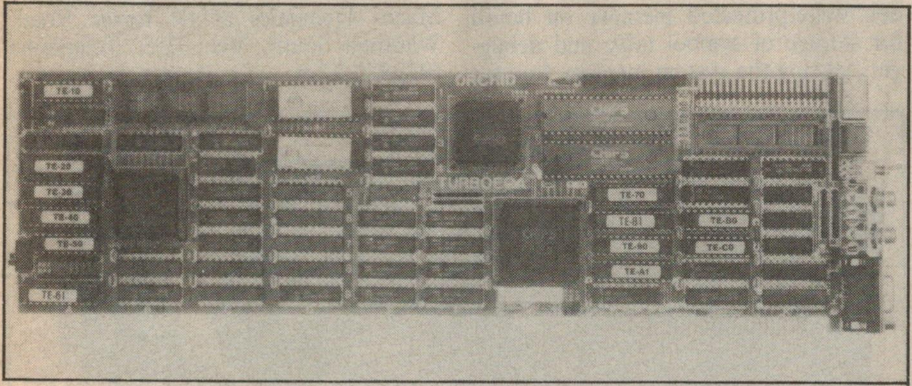
For further information, contact Icom Australia, 7 Duke Street, Windsor, Vic. 3181. Telephone (03) 51 2284.

PCB mounting piezoelectric buzzers

Three new piezoelectric buzzers are now available from IRH Components. The Murata buzzers are compact in size, lightweight and do not produce electrical interference.

They provide a clear and penetrating alarm which can be heard through surrounding noise over a considerable distance. All have internal driving circuitry, which operates over a range of 3V to 20V DC. Current drain is 12mA at 12V DC.

For further information contact IRH Components, 32 Parramatta Road, Lidcombe, NSW 2141. Phone (02) 648 5455.



be run as well as programs for the new EGA stand.

For further information, contact Electronic Solutions, PO Box 426, Gladesville, NSW 2111. Telephone (02) 427 4422.

New Products...

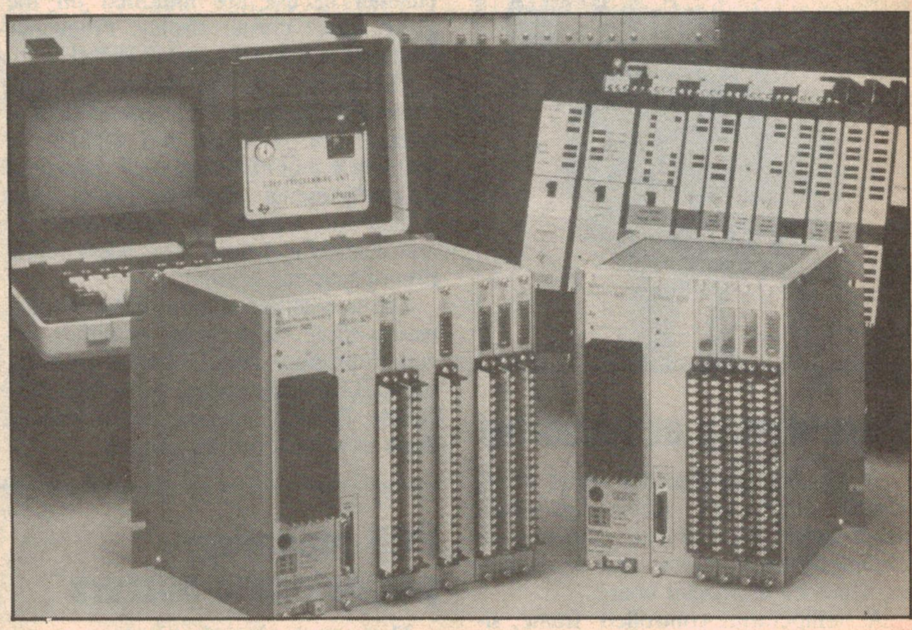
New PLC from Texas Instruments

The 525 programmable logic controller (PLC) is small, robust and less than half the price of other PLCs, making it ideal for a much wider range of equipment.

In addition, the 525 PLC is a fully functional member of the Series 500 family, which allows manufacturers to easily link it with more sophisticated units.

It has the flexibility of discrete, word, analog and relay programming and is compatible with VPU2-00 and TISOFT software. It also has a separate EPROM programmer and a built in RS232-C programming port so that users have the choice of a Texas Instruments hand-held terminal or ordinary ASCII terminals to program it.

For further information contact Texas Instruments Australia Ltd, 6-10 Talavera Road, North Ryde, NSW 2113. Telephone (02) 888 1122.



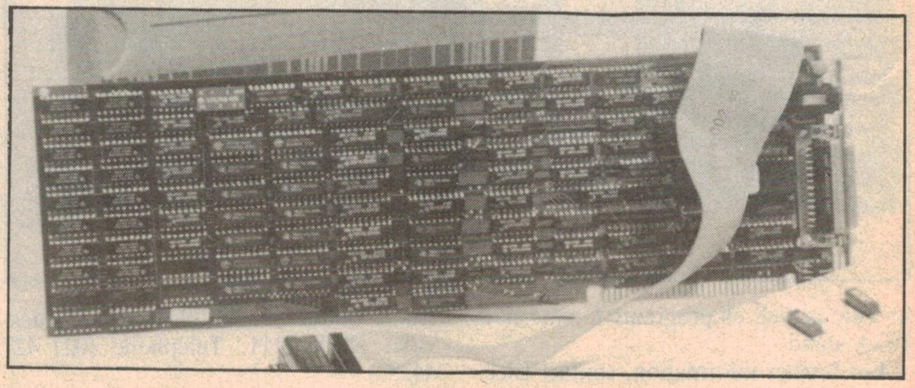
Debugger for IBM PC/XT

Macro Dynamics has recently released the Atron PC Probe which is a real-time hardware-assisted software debugging aid that plugs into a PC/XT slot.

The PC Probe has 128k bytes of hidden write-protected memory on board for storage of symbol table and debugger, leaving the system memory free for the program being debugged.

The history of program execution is saved on-board, in real time. Once a hardware trap has occurred the program history can be displayed in detail. Source Level Debug is supported for C, Pascal, Fortran and Macro Assembler.

For further information contact Macro Dynamics at 80 Lewis Road, Wantima South, Vic. 3153. Telephone (03) 220 7260.



50 and 25 years ago...

"Electronics Australia" is one of the longest running technical publications in the world. We started as "Wireless Weekly" in August 1922 and became "Radio and Hobbies in Australia" in April 1939. The title was changed to "Radio, Television and Hobbies" in February 1955 and finally, to "Electronics Australia" in April 1965. Below we feature some items from past issues.

Wireless Weekly 3d

May 1937

Stirling model with air-cell: From Sterling Radio we have received a sample chassis of one of their seven-valve dual-wave chassis which is known as type A723. This is one of the outstanding battery-operated receivers listed in the air-cell range, quite an amount of careful design having been expended in producing such a powerful receiver to come well within the limits of filament drain imposed by the use of air-cells.

By using a selection of Australian, American and Continental valve types the filament drain has been kept down and excellent gain and general performance obtained.

Amplifier at Olympic Games: (caption) A most powerful amplifier system was used at the last Olympic Games in Germany. Here is a view of the central control station for the amplifiers, which were capable of pouring out three kilowatts of audio power. Wouldn't the neighbours be happy if you tuned up a three kilowatt amplifier in your workshop!

RADIO, TELEVISION and HOBBIES

May 1962

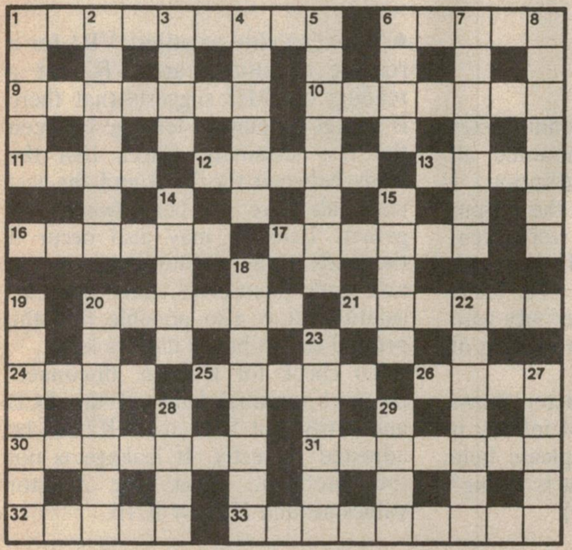
Automatic weather station: The US Bureau of Standards, in cooperation with the US Weather Bureau, has developed a specialised digital computer for the Weather Bureau to use as a research tool in exploring the concept of automatic weather stations. It is known as Amos IV.

To store data, the machine uses a magnetic drum operating at 1,800rpm that carries 100 general storage channels of 100 words each and has space for 100 additional channels. Several dual-head channels are available for simultaneous read-in and read-out of incoming data, out-going, messages etc. The magnetic drum provides the extensive storage capacity required for the table look-up involved in the calculations of runway visual range and approach light contact height. About 35 tables are stored on the drum; each table has about 90 three-digit values.

MAY CROSSWORD

ACROSS

1. Type of filter. (9)
6. Name famous in x-ray study of crystals. (5)
9. Widens audio range. (7)
10. Reproduce signal inaccurately. (7)
11. A.O.C.P. candidates sit for it. (4)
12. Inert gas used in flash tubes. (5)
13. Binary number 101. (4)
16. Microwave antenna cover. (6)
17. Transform data. (6)
20. Telecom's videotex service. (6)
21. Most common conductor. (6)
24. Mast supports. (4)
25. Radio navigation system. (5)
26. Keep circuit in particular state. (4)
30. Improve specification. (7)
31. Charge per second. (7)
32. Abnormal transient. (5)
33. Data measurment and transmission. (9)



DOWN

1. Wave peak. (5)
2. Subjected to light. (7)
3. Male Nobel prizewinner in physics in 1957. (4)
4. Evidence of dramatically poor taping. (6)
5. Phone-based TV data system. (8)
6. Brand of hifi loudspeaker system. (4)
7. Oxidise metal surface electrolytically. (7)
8. What the Parkes telescope does to stellar radiation. (7)
14. Satellite system for amateurs. (5)
15. Elementary particle. (5)
18. Inventor of the triode valve. (2,6)
19. Neutralise a magnetic field. (7)
20. Space probe to Jupiter and beyond. (7)
22. Circuit-breakers do it. (7)
23. Unit of pressure. (6)
27. Some photos in magazines look so. (5)
28. Soldering machine. (4)
29. Electrically-powered rail vehicle. (4)

Apology

We really goofed in April and published the incorrect grid with the clues (no, it wasn't meant to be an April fool's day gag). We apologise to readers and will publish the correct grid with the clues in June.

Information centre

Ultra-low distortion oscillator

I was most interested in your Ultra-Low Distortion Oscillator project (December 1986 and Janaury 1987), having recently designed a similar unit for the testing of active filter circuits. There is a marked similarity in our designs, both being state-variable oscillators with FET level control and using similar operational amplifiers (mine uses the Signetics NE5532 — a dual, internally compensated version of the NE5534 used in your design).

The principal differences are in the level sensing circuitry (a two phase, full wave, active rectifier replaces your sample and hold circuit), in the omission of your "Amplitude Control Multiplier" (IC6) — feedback being applied directly to both the inverting and non-inverting inputs of IC1 — and in the squaring circuitry (bipolar instead of FET).

From my experience in building two units (one general purpose and one providing preset frequencies for production line testing purposes) I offer the following comments on your design:

(1). I would strongly recommend the use of an all-metal case and a mains filter if minimum noise levels are to be achieved.

(2). If the square wave at the junction of Q6/Q7 is brought out to a connector, it can be used (with appropriate setting of VR6) as a TTL or CMOS clock.

(3). The range of VR6a/VR6b should be limited to 10dB by fitting 4.7kΩ resistors in series with the bottom end of each section and increasing the 10kΩ resistor in series with VR6b to 15k. This will prevent the common but undesirable tendency to use low settings of VR6 instead of resetting the attenuator.

(4). The optimum value for the resistors (nominally 68Ω connected to S1 position 4 is that which results in minimum variation of the gate bias on Q1 as the frequency is swept from 10 to 100kHz.

(5). The optimum value for the 560kΩ distortion adjustment resistor can be determined using only an oscilloscope by selecting the resistor value which gives minumum distortion in the waveform on the drain of Q1.

With a dual-trace oscilloscope, this waveform can be compared with the essentially undistorted output of the oscillator either by superimposing, or by subtracting, the two traces. With a single trace instrument, the waveform symmetry must be judged by eye, but the setting is not over critical — as the Q1 drain signal is only 1% of the main waveform, 10% distortion here causes only 0.1% distortion in the output.

(6). I can see little advantage in the inclusion of the metering circuit. Where the output level is critical, the typically (3%) accuracy of a low-cost analog meter is unlikely to be adequate, otherwise a reasonable indication (probably better than 5%) can be obtained from a scale on VR6 or by a simple voltmeter monitoring Vs (the output of IC9).

(7). Probably because of the use of 1% metal film resistors and 1% polystyrene capacitors for the gain and frequency determining components, I found it unnecessary to provide the Frequency/Level presets present in your design. The additional cost of using precision components appears to be less than the cost of the presets (much less if labour costs are considered), although I realise that availability may be a problem to some constructors.

Two other features of my design may be of interest. Firstly, my frequency adjusting potentiometers (your VR5) are connected as dividers between the amplifier output and earth, with a fixed resistor from the wiper to the integrator input sees a substantially constant im-scale (or a logarithmic scale if log pots are used), avoiding the cramping apparent at the upper end of your scale.

Also, as the potentiometers are of relatively low resistance the amplifier input sees a substantially constant impedance thus minimising the variation of offset voltage with frequency setting (this is important to my design in which the level sensing circuitry and output are directly coupled, but would be of little consequence in your capacity coupled circuit).

Secondly, my sine wave output level is controlled by using the square wave supply (Vs) as the sine wave reference voltage, thus ensuring accurate tracking of sine and square wave amplitude and requiring only a single potentiometer. In your circuit this could be achieved by returning the upper end of VR7 to the output of IC9 (Vs), and omitting VR6a.

In conclusion, let me congratulate you on a very worthwhile project. The now ubiquitous function generator (which can usually guarantee only 1%

Can't calibrate megohm meter

I recently built the Megohm Meter (EA, July 1985) and mounted all parts according to specification. I found that I could adjust the output of the inverter to 1000V very accurately with no problems. However, it is not possible to adjust VR1 for a reading for a reading of infinity with the leads open circuit or a reading of 2MΩ reading with VR2.

With open leads the meter shows 500MΩ and adjustment of infinity is not possible. Could you please help me as I do not know what is wrong? (I.Z., Bondi Beach, NSW).

• Your inability to adjust VR1 for a reading of infinity and VR2 for a reading of 2MΩ suggests that there is a large amount of leakage between the test terminals. Check that the leads between the PCB and the test terminals have not been twisted together. Leakage may also occur if the leads to the test terminals, or the test leads themselves, have poor insulation. It is also possible that the printed circuit board itself is leaky.

To check for leakage, disconnect the test terminal leads at the PCB and verify that VR1 and VR2 can be adjusted correctly. If leakage is not the problem, check the resistor values around IC1c or IC1b.

distortion) is of limited use in the testing of circuitry having high-pass or bandpass frequency response and an economical successor the Wien-bridge thermistor-stabilised oscillator is long overdue. (A.E., Titahi Bay, NZ).

• Thanks for your comments on this circuit.

Problem with electric fence controller

Having previously constructed your December 1985 Electric Fence Controller, I decided I needed slightly more "punch" so I eagerly attacked the construction of the "Fencemaster" from EA October 1986. I made my own circuit board from your published overlay and commenced construction. It did not take too long to discover the artwork error as published in Information Centre for February 1987. However, the project still does not work and I was hoping you would give me some advice.

I have followed the suggested procedure under "testing" in the article and have noted the following: with no load on the inverter (just a meter) a reading of 250V DC is detected and the needle flicks to the left, indicating that the SCR is firing.

As soon as the 10kΩ resistor is connected across pins 1 and 2, the inverter output drops to zero and the BUZ71's overheat badly. I first thought I had miswound the primary of the inverter transformer, but after rewinding the primary, I got no output from the inverter at all, indicating, I hope, that the inverter transformer is now beyond doubt (I rewound it).

From the limited abilities of my CRO it seems that when the load is connected, the PUT starts to oscillate and it appears as though the inverter is feeding into an apparent short-circuit with the SCR misfiring all over the place.

As soon as the load is removed, the output shoots back up to 250V, the trigger circuit resumes correct operation, and the transistors cool down. I have replaced the PUT, the timer IC (it only works with a TTL 555 as the CMOS version just sits there and gets hot), the transistors and the TL071, and have established that the two other ICs are working.

I am at a loss as to the trouble as I have checked and re-checked everything. I would be most grateful for advice as I hate having to chase the cows out of the yard each night!

Incidentally, your circuit overlay shows a 47kΩ resistor connected to the gate of the PUT while the circuit diagram specifies a 6.8kΩ. Also, the 470kΩ resistor adjacent to IC4 should be 1MΩ. I chose to use the resistors specified in the circuit and changing these has no visible effect on operation. Perhaps you could also explain why the CMOS 555 gets hot and the TTL one doesn't. (R.T. Wodonga, Vic).

• From the symptoms you have given, we suspect that you have a faulty 7555 timer IC. This, in turn, may have resulted in damage to Q1 or Q2 due to overheating.

You should also check that the gate signal to Q1 is 180 degrees out of phase with the signal to Q2. The resistor on the gate of the PUT should be 6.8kΩ as shown on the circuit diagram.

Vifa-EA 60/60 loudspeakers

It is with some hesitation that I write to criticise but within the article in the September 1986 issue of EA describing the Vifa-EA 60/60 loudspeakers there appears to be three fairly important design inconsistencies. These are as follows:

(1). The calculated volume of the enclosure is approximately 18.6 litres whereas the text quotes a volume of 35 litres.

(2). The system frequency response curve accompanying the text quotes a box volume of 35 litres; as no port dimensions are given I assume this curve is for a sealed box.

(3). Although the text refers to the box as a sealed enclosure, it appears however, to be vented by a 49mm diameter port in the rear panel. I would appreciate your comments on the above.

However, in a more constructive vein, and assuming that the design was intended to make use of the Thiele-Small parameters in the small volume vented enclosure shown in the drawing, I have three queries: What is the frequency response of the system including port radiation? Why is the port not in the front panel? What special precautions or modifications are desirable, if any, to limit input voltage at low frequencies near cut-off to avoid damage due to excessive voice coil displacement? (P.G., Salisbury, SA).

• The volume of the enclosure for these loudspeakers is 18.6 litres as you have correctly calculated. Both the text and the labelling on the frequency response graphs are incorrect.

Please note, however, that the top frequency response curve (page 38, September 1986 issue) is for the tweeter on an open baffle, while the response curve below is for the woofer when mounted in the 18.6 litre enclosure.

There is no vent in the box — the enclosure is fully sealed. The 49mm diameter hole in the rear panel is for the loudspeaker terminal panel and is fully sealed when this panel is screwed into position.

Finally, the loudspeakers may be protected by adding polyswitch protectors to the crossover network. The details were published on page 4 of our October 1986 issue. The polyswitch protectors are available from Jaycar Pty Ltd, 115 Parramatta Road, Concord, 2137.

Remote infrared TV sound control

Recently I made one of your projects, the Infrared Remote TV Sound Control from your January 1983 edition, and I have struck a problem. When I put 15V through the circuit, the regulator gets very hot and when I put 20V from the TV through, its gets too hot to touch. I assume this should not happen and I don't know what the problem is. I have checked the voltage on the regulator input and output pins and they are correct. Can you help? (G.R., Holland Park, Qld).

• We suggest that you first check the output of the 7805 3-terminal regulator. You should get a reading of 9V due to the resistors at the common terminal. If this voltage is incorrect you may have the regulator in the wrong way around.

Conversely, if the voltage is correct, check for short circuits on the board and incorrect value resistors. If necessary, a small heatsink may be fitted to the regulator to keep its temperature to a safe level.

Notes & Errata

ESTIMATING NOISE IN OP AMP STAGES (April 1987): a formula was left out of the text at the end of the second paragraph. The full text is as follows:

It must be appreciated that any resistor has a self noise level caused by thermal agitation of its free electrons. This noise, commonly known as white noise is random and spreads across the whole frequency spectrum. Its magnitude is given by a simple formula:

En = 4.K.T.B.R

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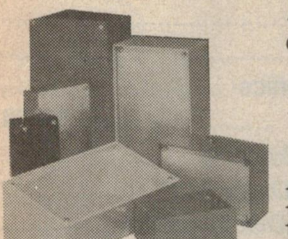

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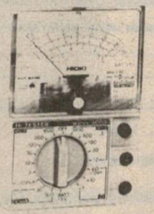

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Multi-function remote control

Here's a multi-function infrared remote control that should have many uses. It can be built in two forms: (1) as a simple unit with up to eight relay output channels; or (2) as a full-featured unit which also adds power on/off, muting, and volume. It can be fitted to a TV set, VCR or CD player, or used to control models or industrial machinery.

The basics of satellite TV

Ever wondered what is required to receive television pictures from satellites orbiting in space? Our main feature article next month is a basic guide to practical satellite TV reception. Don't miss it.

Remote-controlled car alarm

Next month, we will give full details on marrying the ultrasonic alarm described in April to the UHF remote switch described in January. Together they make an ideal car burglar alarm.

**Note: although these articles have been prepared for publication, circumstances may change the final content.*

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